

# ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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# ANNALS *of* SURGERY

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## THE RELATIONSHIP OF MASSAGE TO METASTASIS IN MALIGNANT TUMORS\*

BY LEILA CHARLTON KNOX, M.D.  
OF NEW YORK, N. Y.

### CLINICAL

ONE of the most important aspects of the practical study of tumors is the determination of the anatomical and biological conditions which facilitate or prevent metastases. These phenomena have long been studied in man without much definite information having been collected. About all we know is that, in general, carcinomata are prone to metastasize through the lymph-channels and sarcomata through the blood-vessels, and that metastases do not always follow in the direction of flow of the current, but in a certain proportion of instances the emboli travel by a retrograde course or the tumors progress by direct extension, the so-called permeation of the lymphatics.

It has been generally assumed, without direct experimental proof, that a number of the factors favoring the production of metastasis are purely physical, for instance, the size and connective-tissue relations of the tumor cells, the pulsating or contractile movements of the organs in which they are implanted, the number of the blood-vessels and the thickness of their walls, with consequent susceptibility to trauma by pressure or massage. On the other hand, accurate clinical study and experimental work as well have caused the occult and convenient theories of tissue predispositions and specific "immunity" of organs to assume a less creditable position than they formerly held, and quite properly, for until it is shown that simple mechanical and biological facts do not account for the peculiarities in the occurrence and distribution of metastases vague theories should not be substituted.

The importance of vascular embolism in the spread of tumors has long held an unchallenged position in instances in which the pulmonary veins were known to be grossly involved and the arterial circulation in that way obviously open to a supply of tumor cells. A valuable contribution on this phase of the subject was made when M. B. Schmidt showed that not infrequently the tumor cells readily pass the pulmonary capillaries and are deposited elsewhere before macroscopic growth appears in the lung. In a study of forty-one cases of primary abdominal carcinomata without extensive gross

\*From Columbia University, Institute of Cancer Research, F. C. Wood, M.D., Director, New York.

metastases, the lungs of fifteen were found to contain microscopic arterial emboli of tumor cells, showing that once the cells gain entrance to the blood stream they may reach any portion of the body and are not necessarily always retained or destroyed within the lungs. This may, however, be their fate, for Schmidt found many small thrombosed vessels with degenerating tumor cells entangled in the clot. These phenomena have been duplicated experimentally by Takahashi and by Iwasaki, both of whom injected tumor cells into the blood stream of animals. Both these authors have well shown that although embolic cells are frequently treated as foreign bodies and phagocytized, many, on the contrary, survive the adverse conditions, and invade and replace the vascular endothelium or undergo mitosis even before they become implanted on the vessel wall.

For purely physical reasons, however, we must suppose that cells of small size accomplish this more readily than do larger ones, and experience shows that the large spindle and giant cells, or those distended with mucus as many from the gastro-intestinal tumors are, do not find their way through the pulmonary capillaries except in small numbers. Whether or not the amoeboid motion of the cells is a factor in facilitating this is not known. That such motion exists was shown by Carmalt in 1872 and later by Lambert and Haynes.

The localization and growth of embolic tumor cells within the dilated capillaries of the bone-marrow have been explained as due to the physiological hyperæmia which is practically constant in that situation. Slowing of the blood current and adhesion of the tumor cells to the endothelium seems to produce circumstances favorable to the growth of such emboli.

Lymphatic embolism, either direct or retrograde, has also been unquestionably a frequent and important means of tumor dissemination; but the status of lymphatic permeation, although very convincingly demonstrated by Handley in certain cases, is perhaps a less constant phenomenon than he at first believed.

The process, as Handley described it, consists in the proliferation of tumor cells which, having gained access to the superficial lymphatics in the proximity of the tumor, continue to grow within them and to extend through their branches, often appearing in the skin, where they form cutaneous nodules. Secondly, there often occurs an inflammatory fibrosis and obliteration of portions of the lymph-channel, a process analogous to the thrombosis which is common in invaded vascular channels. Handley studied especially breast carcinomata and melanomata—two of the tumors which most frequently exhibit regional cutaneous recurrences and extensions; and it is on the basis of his evidence that one may perhaps regard some of the recurrences in surgical scars as accidental occurrences due to the proliferation of tumor cells present in the lymphatics prior to the incision, though possibly accelerated in growth by the increased vascularity of the wound area. Probably, however, a majority of the local recurrences are due to a mechanical transplantation from an infected to a non-infected field.

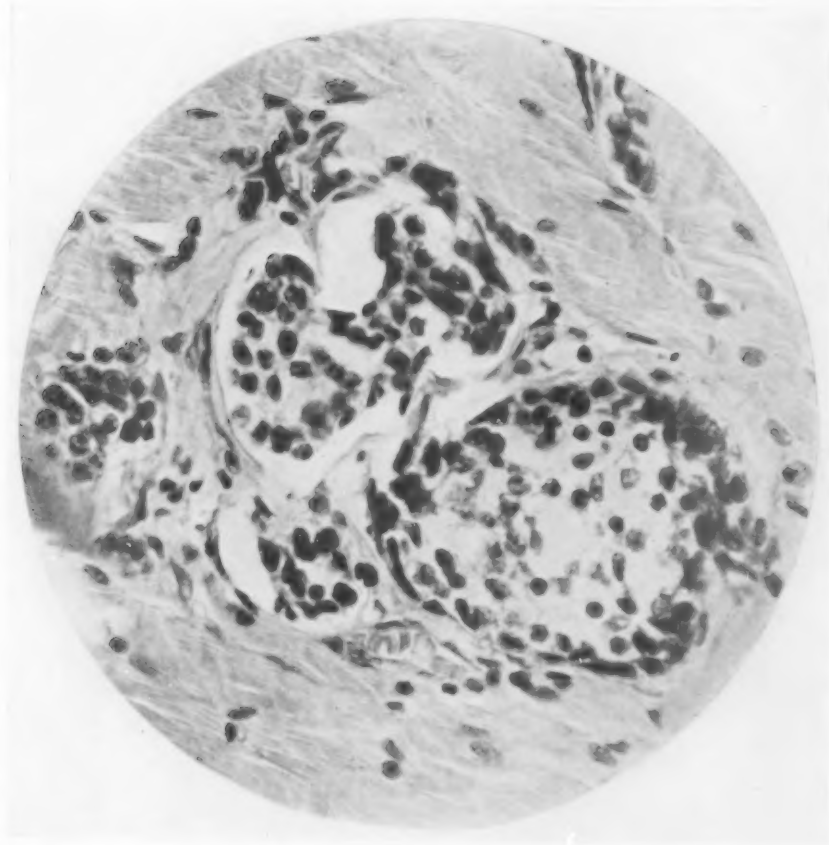


FIG. 1.—Metastasis of breast carcinoma in pectoralis muscle following massage in man.



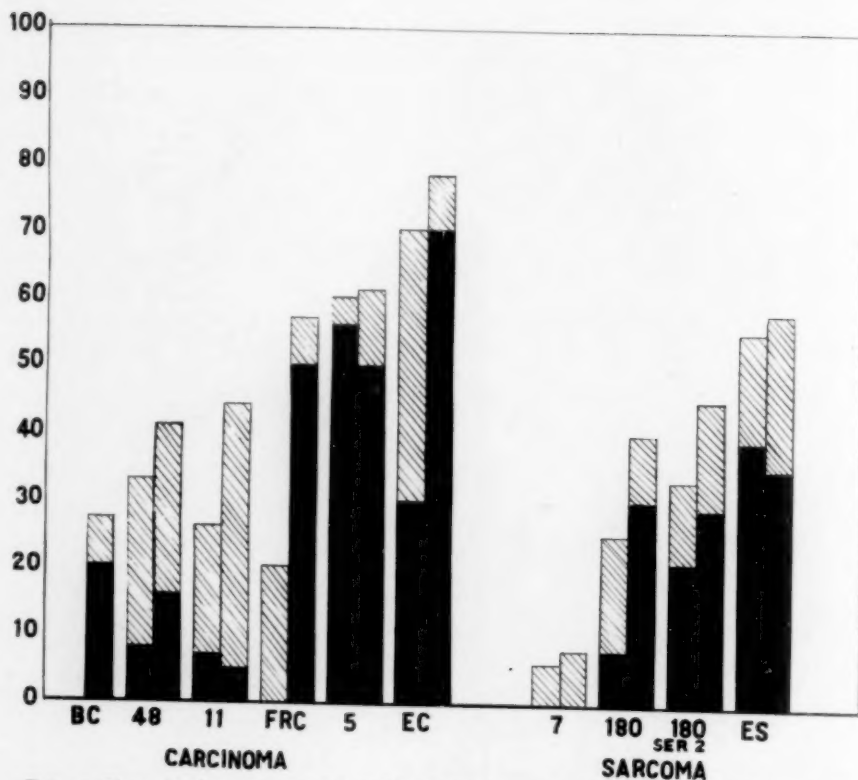


FIG. 2.—Chart showing percentage of emboli (hatched areas) and of metastases (solid areas), and their relative numbers in controls and massaged animals. In each case the column at the right represents the massaged animals, that at the left, the controls.

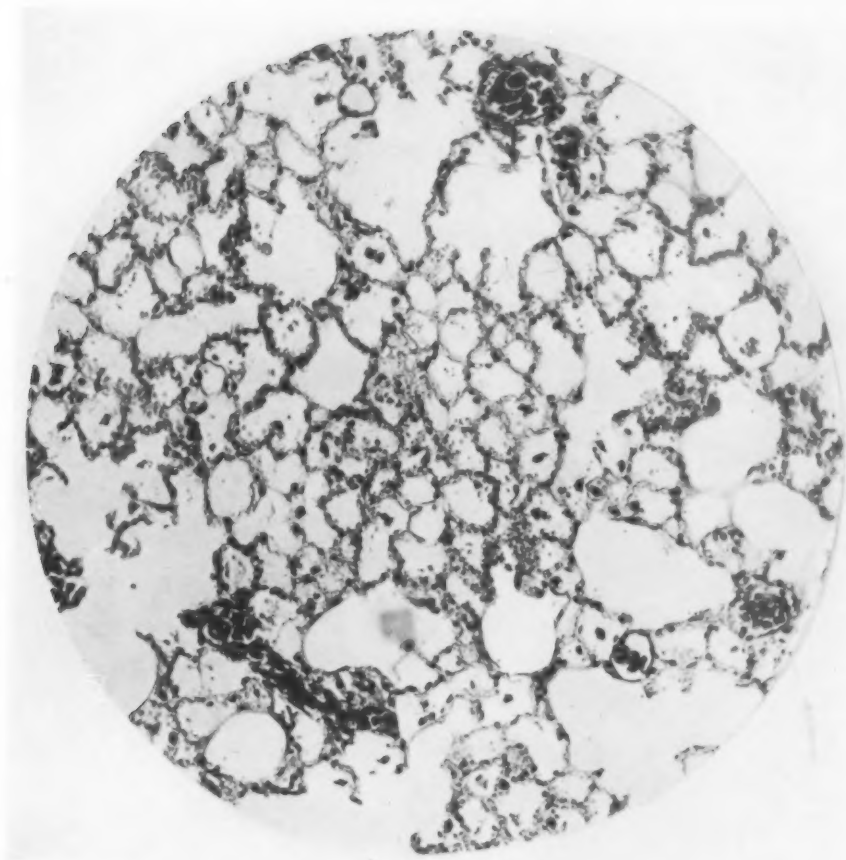


FIG. 3.—Multiple emboli of tumor cells in pulmonary vessels of a massaged mouse tumor.

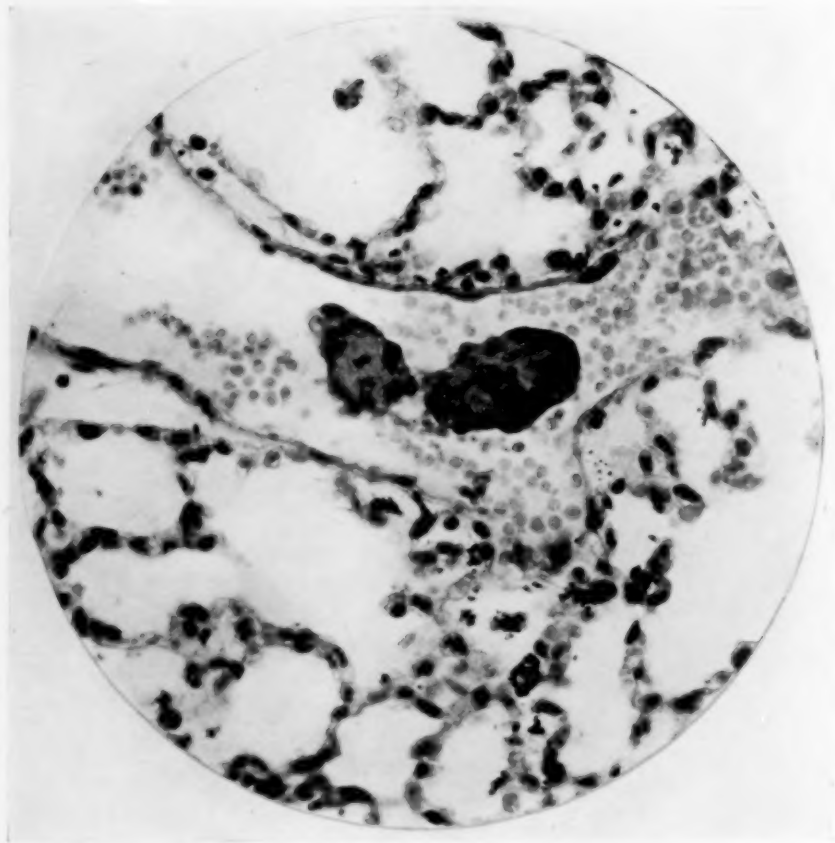


FIG. 4.—Degenerative changes in cells of a tumor embolus in pulmonary vessels.



## MESSAGE METASTASIS

In the case of the melanomata this mechanical transfer by operation is not a completely adequate explanation, for the nodules are often found far from the region of the incision, and, indeed, are frequently seen in unoperated cases, giving a striking illustration of the fact that tumor cells, especially those of moderate size, have the capacity to invade the cutaneous lymphatics for long distances and to spread against the direction of flow of the lymph. When the vessel is large, as in the abdominal trunks, permeation would not be expected to occur, and it is probable that extensive backward spread of tumor cells is due to a combination of several processes. Vogel has described two such cases, one a carcinoma of the gall-bladder, which extended into the left kidney hilus and there perfectly outlined the perivascular lymphatics of that region; the other a pancreatic carcinoma which extended directly along the mesenteric and aortic trunks into these nodes.

It is well known also that œsophageal carcinomata are prone to spread longitudinally along the lymphatics of the submucosa and that small secondary nodules often appear considerably below and separated from the oldest portion of the tumor by uninvolved mucosa. It used to be the fashion to describe these as implantation growths, but this view is now generally abandoned. Zahn has even described one situated as high as the tracheal bifurcation, but associated with three small carcinomatous nodules beneath the mucosa on the gastric side of the cardia. This occurred also in an œsophageal carcinoma with tracheal fistula (St. Luke's Hospital, No. 1309), the secondary nodule being 4 cm. from the main mass of the neoplasm. The mechanism of the formation of these multiple nodules, as well as of multiple papillary gastric carcinomata, has not been shown to be necessarily a process of permeation, although theoretically this would readily explain their occurrence.

On the other hand, emboli are, no doubt, prevented from growing by the mechanical activity of muscles and muscular organs. Metastases are singularly rare in the cardiac muscle, being practically never seen except in the case of extremely vascular tumors with scanty stroma from which the loosened cells spread and overwhelm the whole arterial circulation with countless emboli. The aortic valves must also act to deflect emboli from the mouths of the coronary arteries. Benecke, studying the invasion of the walls of vessels from carcinomatous thrombi, believed that the infrequency of metastasis in the muscular coat was due to the physiological tonus of the muscle. This is a reasonable conclusion, and the principle holds good for striated muscle as well. Metastases into the latter are extremely rare, due in part to the contractility of the fibres, a condition which offers considerable resistance. The fact that lymphatics are lacking within striated muscle bundles is certainly not the reason for the rarity of metastases, for if the emboli were lymphatic, not vascular, and if the motion did not play so large a part in preventing their growth, they should be present in tendons where lymphatics are very numerous. Direct permeation of both striated and unstriated

muscle is, however, frequently seen, showing that the soil is not unsuitable provided the cells once gain access to the tissue.

Normal peritoneum has been shown by Jones and Rous to possess a high resistance to the implantation of tumor cells, but when it was injured by a mechanical irritant, tumor growth was at once made possible. This offers an explanation for the frequently observed fact that carcinoma of the stomach often metastasizes into the ovary, producing the so-called Krukenberg tumor of the latter organ, without any intermediary deposits on the peritoneal surface. That such deposits will eventually occur in late stages of carcinomatosis is, of course, well known, but it is probable that the constant motion of the opposed serous surfaces is an important factor in destroying whatever cells may find their way to it. It has long been recognized that it is the gelatinous carcinomata of the ovary, stomach, and intestine that are most widely distributed in the abdominal cavity. This is, of course, as would be expected, for the bulk and consistency of the mucus make it in a sense a foreign body and must keep the cells in contact with the peritoneum and also irritate it, and so indirectly facilitate adhesion and ultimate vascularization, whereas a few free cells would be more likely to be destroyed.

Post-operative human results have occasionally shown the remarkable persistence which cells from malignant tumors may exhibit. During the quiescent period the cells are probably most frequently inactive in the lymph-nodes, occasionally for as long as ten to twenty years. Late recurrences usually appear first in the nodes to which drainage was directed, and if the morphology of the tumor is that of the primary growth there can be no question that these are really late recurrences from previous metastatically deposited cells. For example, small groups of living cells from a gastric carcinoma have been observed by Rohdenburg in the liver and omentum ten years after the operation on the primary tumor, with a clinical cure. Such a case may be the result, like many of the very late cutaneous recurrences from breast tumors, of slow permeation along the efferents of a node or even from a small group of cells for years quiescent in the tissue spaces.

A spindle-cell sarcoma has occasionally recurred after a very long period. A tumor of this type, originating in the cervical fascia, has been seen by the writer recurring as a mass the size of a walnut twelve years after the first operation, the patient being free from symptoms during the greater part of the period. Such a phenomenon is difficult to explain, since only rarely does this type of sarcoma metastasize into the lymphnodes, and there form a focus for new growth. As this recurrence was in the centre of a large skin graft made at the first operation, it seems more probable that it was a recurrence *in situ* of very slowly growing cells situated in the deep fascia below the graft.

Other rare and late metastases which give no hint as to the mechanism of their localization and long course are cited by Schmidt and Goldmann, who observed a cerebral metastasis four years after a rectal carcinoma with no local or lymphatic return. Schmidt believes that such tumors are derived

# MESSAGE METASTASIS

from latent intravascular cell groups in the pulmonary vessels. Another still more remarkable observation is that of Crouzon, who described a cerebral metastasis eighteen to twenty years after operation on a bilateral breast carcinoma. Gathmann and Schmidt have each observed cases in which four years after operation on similar tumors, with apparent cure, widespread skeletal metastases appeared. In such a case a general emboli distribution of cells by the blood into the capillaries of the myeloid canals must have occurred fairly early, and the growth processes have been very slow.

The frequency of skeletal metastases is so much greater than can possibly be demonstrated by clinical or röntgenological means until a very

TABLE I  
*Carcinomata*

	Number animals	Number of animals with met- astatic tumors	Number emboli	Total no. animals with met- astatic particles	Per cent. metastases	Per cent. emboli	Total % metastatic particles	Difference of % in me- tastases in controls and massaged animals
<i>F. R. C.</i> .....								
Controls.....	15	3	0	3	20	0	20	
Massaged.....	14	7	1	8	50	7	57	37
<i>B. C.</i> .....								
Controls.....	5	0	0	0	0	0	0	
Massaged.....	15	3	1	4	20	7	27	27
<i>E. C.</i> .....								
Controls.....	10	3	4	7	30	40	70	
Massaged.....	13	9	1	10	70	8	78	8
<i>No. 5.</i> .....								
Controls.....	23	13	1	14	56	4	60	
Massaged.....	18	9	2	11	50	11	61	1
<i>No. 11, series I.</i> .....								
Controls.....	26	2	5	7	7	19	26	
Massaged.....	18	1	7	8	5	39	44	18
<i>No. 11, series II.</i> .....								
Controls.....	15	3	1	4	20	7	27	
Massaged.....	21	4	2	6	19	9	28	1
<i>No. 48.</i> .....								
Controls.....	12	1	3	4	8	25	33	
Massaged.....	12	2	1	3	16	25	41	8

advanced stage that the high percentage of such growths is not often appreciated. Although the vascularity of the marrow is great, the stroma reaction may be here as marked as elsewhere and the metastasis of a scirrhous breast carcinoma be only a sclerotic nodule of the same appearance as the primary growth. When the bones are noticeably eroded or spontaneous fractures occur the process is far advanced and statistics drawn from such cases only give misleading data as to the frequency of the process.

This view of the localization of metastases has not, however, been universally accepted, and many convenient hypotheses have had to give way to the increasing weight of pathological and experimental evidence. The theory of the specific adaptation of some tissues, as the liver, for neoplastic cells, and the relative immunity of others, as the brain, has been prevalent in



the literature for many years. Virchow stated that organs in which carcinoma is never primary do not serve as a site for metastases. Recent observation has shown these conclusions to be wholly incorrect, as the brain is the site of secondary metastatic carcinomatous deposits in at least 0.3 per cent. of all autopsies (Krasting). Adherents to this theory point out, however, that some types of tumors have distinctly greater capacity to metastasize into certain organs than others, since not all tumor cells readily grow within the bones, but others very commonly do so, as those of the breast, thyroid, adrenal and ovary. Von Recklinghausen even advanced the idea that breast and prostatic carcinomata were apt to form metastases in similar regions because they were in a sense analogous organs, each being a part of the genital system. Bamberger and Paltauf believed that there was some specific organ susceptibility, and offer as evidence the fact that not only the small-cell carcinomata of the prostate metastasized to the bones, but the large-cell medullary carcinomata of the gland behaved in the same way.

The spleen also has been called "immune" to metastases by various writers because gross tumors in it are not especially frequent and microscopic ones often escape detection; but late stages of breast carcinoma are not infrequently accompanied by palpable enlargement of that organ due to a diffuse carcinomatosis, while E. E. Goldmann demonstrated that animal tumors inoculated into the spleen grow as readily there as elsewhere. While the vascularity of the organ exposes it to numerous emboli, yet as it possesses no efferent lymphatics and is in practically constant motion, embolic cells can not proliferate within it with as much facility as in some other organs. The great vascularity of the adrenals, as well as their protected position and absence of intrinsic motion, provides a suitable location for the secondary growths so often found in them. It is possible that the wide vascular sinuses of the pituitary, which resemble those in the adrenal, facilitate the location of metastatic tumors in this organ as well.

External mechanical influences have for some years been recognized as an important factor in dealing with any malignant tumor. Gerster, in 1885, discussed the apparent breakdown of the forces which keep a malignant tumor for a time localized, and believed them to be largely mechanical. He pointed out the need, for example, of high amputation, not alone for the purpose of obtaining an uninfected field, but in order that the neoplasm itself should be free from manipulations, and so facilitate cellular dissemination. This writer further compared the results of malignant tumor massage to that which is sometimes effected by massaging a sprained joint—a process which certainly disseminates inflammatory exudate rapidly and widely. The effect of pressure, rubbing, or active massage on the tumor has been frequently observed in human beings as the result of osteopathic or massage treatment of malignant tumors, and many examples have been seen in recent years of wide dissemination of a primary growth very effectively accomplished by this procedure.

Such an instance has recently occurred at St. Luke's Hospital, and fur-

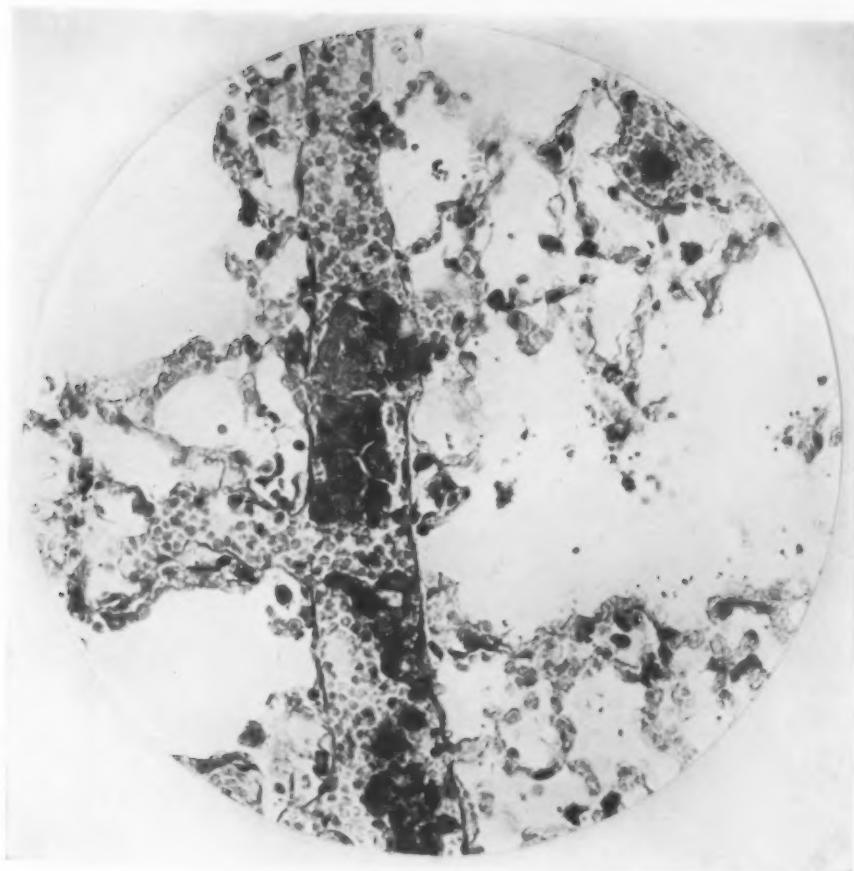


FIG. 5.—Embolus of tumor cells in pulmonary vessel. Embolic cells are undergoing early degenerative changes. The lung tissue is well preserved.

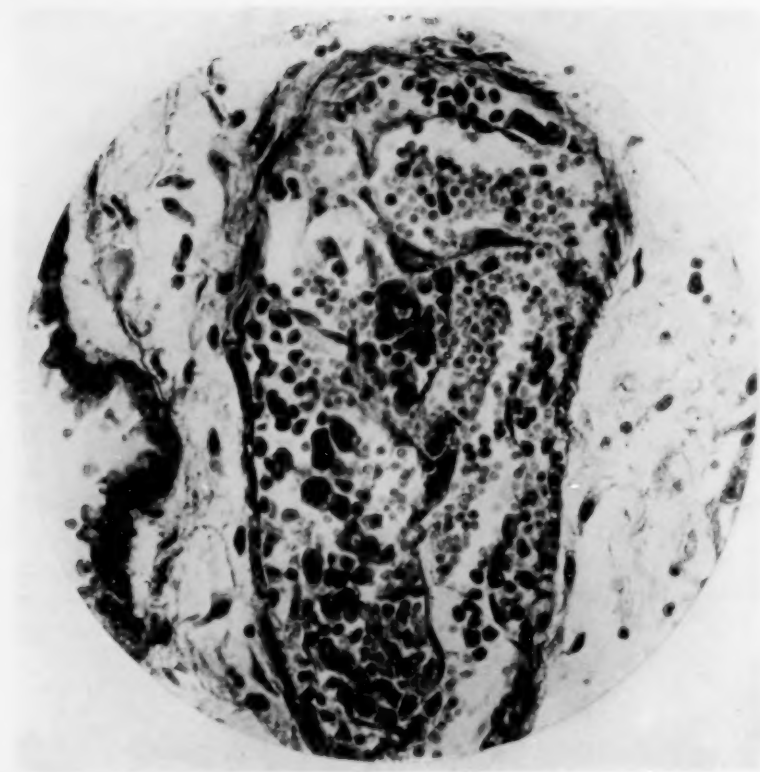


FIG. 6.—Endothelium of vessel containing embolic tumor cells stripped from wall. Early stage of attempt to localize.

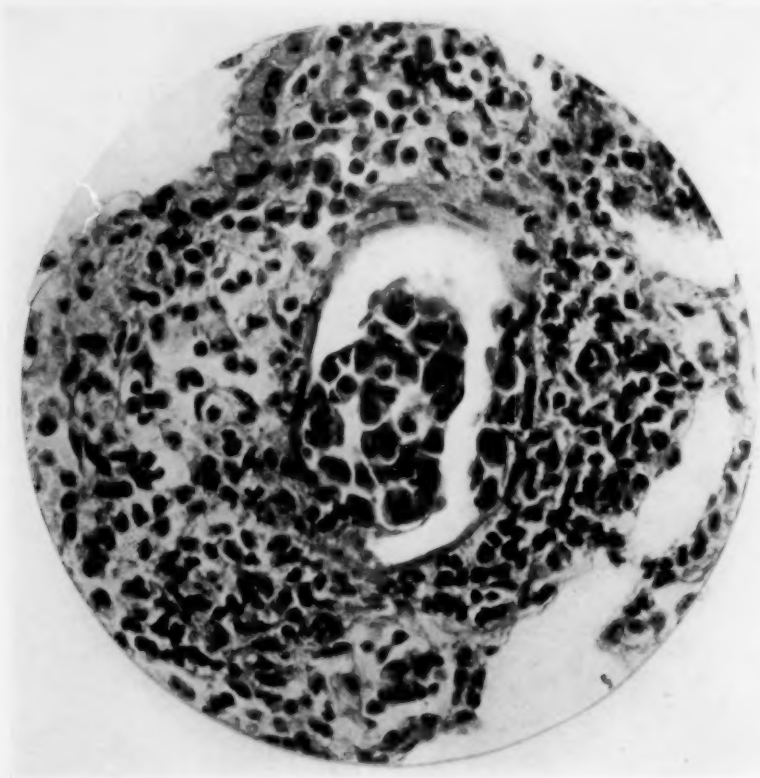


FIG. 7.—Later stage in implantation of embolic tumor cells. A few have replaced the endothelium.





FIG. 8.—Small embolus from case of carcinoma of stomach in man, showing invasion of pulmonary vessels. Nuclei surround a central mass of mucus.

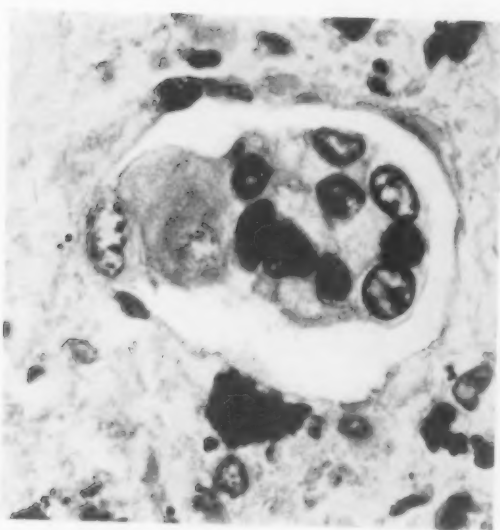


FIG. 9.—Beginning adhesion of tumor cells to endothelium in pulmonary capillary from case of carcinoma of stomach in man.

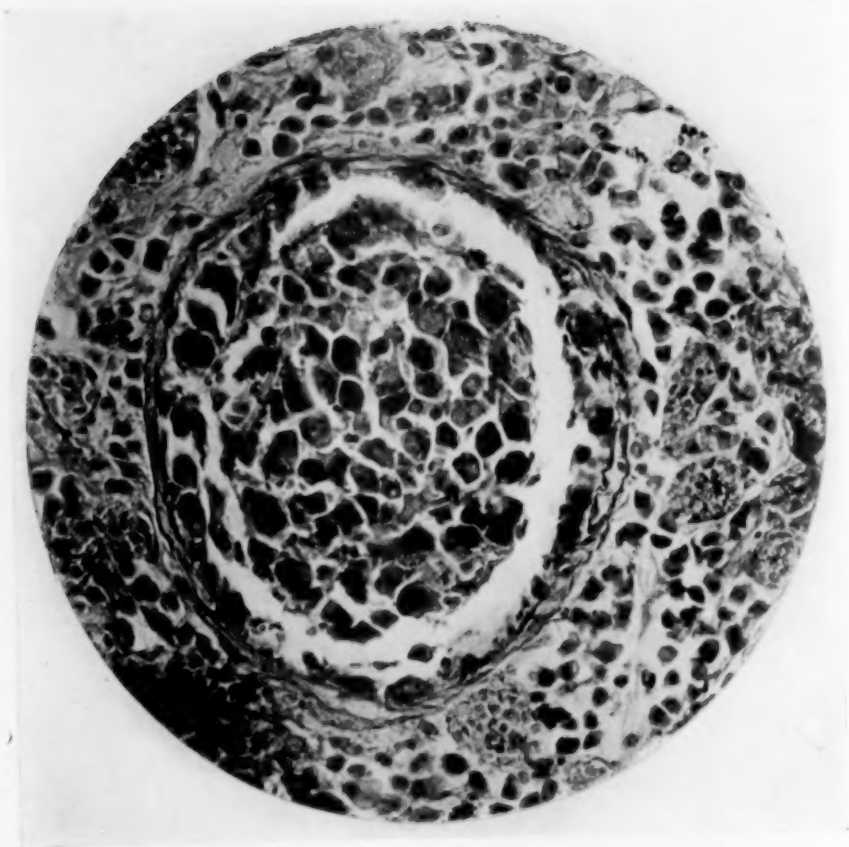


FIG. 10.—Embolic tumor cells replacing endothelium of pulmonary vessel.

## MASSAGE METASTASIS

nishes one of the rare instances in which extensive gross metastatic invasion of muscle could be observed. The patient stated that massage treatment had been regularly employed for some time previous to admission. When the breast tumor was examined there was found a fairly extensive area of eczema overlying a large very hard tumor which was fixed to the pectoralis fascia. Small white tumor nodules were scattered widely throughout the muscles, even invading the individual fibres. (See Fig. 1.)

### EXPERIMENTAL

While, therefore, much interesting and important information has thus been obtained by clinical, operative, and post-mortem studies, the number of cases is too small to enable final conclusions to be drawn.

The determination of the weight of a factor in producing metastases can not be judged from single experiences on man, as it is impossible to eliminate conflicting conditions. Only by the use of a homogeneous material in which the size of the cells, their histological and biological qualities, and the vascularity of the surrounding tissue, etc., are practically constant can valid conclusions be drawn, and this elimination of variables is possible to obtain only by the use of animal tumors of a long transplanted strain, so that the morphological and biological characters are well known. The possibility of obtaining by inoculation in a single day more tumors than any one surgeon observes in a lifetime of active practice also eliminates the occurrence of errors due to random sampling affecting the result—a condition never possible in human material. For example, following the discussion produced by the publication from the Crocker Fund of a paper on the results of the incision of tumors, many surgeons brought forward individual instances which they thought were of value in proving the danger of diagnostic incision, not realizing that from a statistical aspect a single instance is of no value. Even from a basis of reasoning, so remote from the complexities of mathematics as what is ordinarily termed common sense, many of those who cited these single instances were unable to deny on cross examination that pre-operative manipulation by the patient, or that dragging or pressure on the tumor during the operation might have equally well caused the evident dispersal of tumor particles, as evinced by the subsequent course of events.

It was not until Tyzzer, in 1913, demonstrated that gentle massage of a transplanted carcinoma in a mouse greatly increased the number of metastases observed in the lung that definite evidence was brought forward to substantiate these occasional clinical observations. The number of Tyzzer's experiments was small, and he obtained results with only one tumor, a highly malignant neoplasm of the Japanese waltzing mouse. With the Ehrlich mouse tumor No. 11 and the Jensen rat sarcoma he was unable to obtain metastases artificially by massage of the implanted tumors. Rous states that his experiments in massaging rats with adenocarcinoma resulted in the death of all the animals, but did not cause more than the ordinary number of metastases.

Several recent clinical experiences of the writer in which after the removal of a very small primary tumor of the breast by perfect surgical technic (no involvement of the axillary nodes being present), the patient died of generalized carcinoma in a short period thereafter, pointed to the desirability of further extension of Tyzzer's experimental results. We will say, in passing, that in one of these human tumors which had been somewhat vigorously palpated by a number of physicians, a small hemorrhagic area was found in the middle of the growth, and in the vessels surrounding the tumor numerous emboli of cancer cells were present.

TABLE II  
*Sarcomata*

	Number animals	Number of animals with met- astatic tumors	Number emboli	Total no. animals with met- astatic particles	Per cent. metastases	Per cent. emboli	Total % metastatic particles	Difference in % of me- tastases in controls and massaged animals
<i>No. 7</i> .....								
Controls.....	16	0	1	1	0	6	6	
Massaged.....	12	0	1	1	0	8	8	2
<i>Ehrlich sarcoma</i> ..								
Controls.....	31	12	5	17	39	16	55	
Massaged.....	26	9	6	15	35	23	58	3
<i>No. 180, series I</i> ..								
Controls.....	12	1	2	3	8	17	25	
Massaged.....	10	3	1	4	30	10	40	15
<i>No. 180, series II</i> .								
Controls.....	73	16	9	25	21	12	33	
Massaged.....	85	25	14	39	29	16	45	12

A considerable variety of transplantable carcinomata or sarcomata of the mouse and rat were used for the experiment. Some of these tumors under normal conditions, especially the spindle-cell sarcomata, do not produce spontaneous metastases in the animals in any number. Others, especially the carcinomata, are apt to metastasize early.

The following tumor strains were employed: Crocker Fund mouse carcinomata, Nos. 5, 11, and 48, the Borrel mouse carcinoma, the Ehrlich mouse carcinoma and the Flexner rat carcinoma; Crocker Fund mouse sarcomata Nos. 7 and 180, and the Ehrlich mouse sarcoma.

The method employed was as follows, with the exception of the two series described separately below: The animals were inoculated subcutaneously in the inguinal or axillary region with a tumor particle weighing about 0.003 gm. When the tumor reached a diameter of approximately 5 mm. it was gently massaged for half a minute every other day for about two weeks. The tumor was then removed by operation to prevent further metastasis, in order to obviate the difficulty of having to decide whether embolic masses in the vessels

## MASSAGE METASTASIS

of the lung were really growing tumor particles, or only recently deposited emboli which might ultimately die without giving rise to a tumor nodule. In the final results only those masses are considered as true metastases in which the vessel wall was invaded, a separate column giving the number of instances in which emboli were found in the lumen of the pulmonary vessels.

In one series, mouse carcinoma No. 11, the experiment was repeated, and the technic was varied as follows: The tumor was massaged vigorously for one minute on each of two consecutive days. After the second massage treatment all tumors, both controls and those which had been manipulated, were excised and the animals all killed twenty-seven days later. (No. 11, Series II.)

In order to check the results a third series of mice were inoculated two years after the first lot with the Crocker Fund mouse sarcoma No. 180. The mice were all of the same breed, and the conditions were kept as nearly as possible the same as in the preceding experiments. This time the mice were inoculated in the right axillary region, and as soon as the tumors were easily palpable the massage was begun on one-half of the mice, the others being reserved for controls. As before, the massage was carried out for thirty seconds on alternate days for about two weeks. The tumors were then very large, and many of the mice died at this time. In those surviving the tumors involved the thoracic wall too extensively to make removal feasible, so the animals were, therefore, allowed to die and then were autopsied. The results of this experiment are recorded as No. 180, Series II.

In all the series the lungs were carefully removed, distended through the trachea with 4 per cent. formaldehyde, and hardened, and six sections from each animal were examined. Much difficulty was experienced in determining microscopically whether a mass of cells in a vessel should be considered as a true metastasis or merely an embolus. When emboli cease to be capable of forming a tumor we do not know. Careful morphological studies have been made by Takihashi and others to determine the early degenerative and proliferative changes which occur in emboli of tumor cells, but the two processes are frequently coincident, and, as many groups showed no evidence of either process even after being in the vessels many days, we cannot be too cautious in deciding whether a death point has been reached. Such emboli were found, for example, in specimens 9515, 6363, 6359, thirty-two, twenty-seven, and twenty-six days after removal of the primary tumor and no local recurrence at the site of inoculation had taken place from which such emboli could have been derived. Presumably such cells are dead; hence these groups have been called emboli, not metastases. In one sense, however, they are just as important as a growing lung tumor in showing that emboli of cancer cells can be set free in the blood stream by massaging a tumor, and any embolus in its early stage carries the potentiality of metastasis formation.

Only six sections of the lungs were studied, for it was found after a few



complete sets of serial sections had been examined that the gain in number of emboli or small tumors discovered was unimportant.

The tabulated records of the experiments are self-explanatory and need no further elucidation.

#### DISCUSSION

Examination of the chart (Fig. 2) shows that, in general, with nine tumor strains, there was a more or less distinct increase after massage in the number of embolic particles in the lungs, the increase varying from 1 to 37 per cent. The actual percentages can be considered of little importance, and it is even surprising to find that the tendency is so general. With the carcinomata the results are in many cases unequivocal; for example, the Ehrlich carcinoma, at the time showing no regression and 75 per cent. of takes, in other words, in its positive phase, formed more than twice as many metastases after massage as without it. A similar condition obtained with the Borrel carcinoma, at that time spontaneously regressing in 50 per cent. of inoculations, but still showing numerous metastases after massage. The ratio is probably artificially high as the number of control animals which survived was very small.

The emboli are found in both lymph- and blood-vessels, frequently in both locations in the same lung. The perivascular space can frequently be seen filled with cells from which the parenchyma is invaded, but the primary process is evidently in the vessels, as it is seen in all stages within them. The lymphatic system of the mouse being developed to a much less extent than in man, it may also be expected to show relatively less tumor involvement. One reason for this may very probably be, as is pointed out by Murray, that the lymphatics are so delicate and quickly obscured by an inflammatory reaction that metastatic particles apparently freely growing in the tissues may have originated from an embolus either in a lymph-vessel or the nodal capsule. In these studies, however, there is seldom room for doubt that the emboli are vascular in the great majority of cases. Multiple emboli nearly filling both large and small vessels of a lobe are occasionally found in the controls as well as in the massaged animals, but cell groups are much more frequent in the treated ones. The illustration (Fig. 3) is from a massaged animal which died twenty-four days after inoculation. Both proliferation and degeneration are seen, and most of the stages described by Takahashi may be found in some area. Fig. 4 (No. 18363) and Fig. 5 (No. 18319) each show a small embolus which is certainly undergoing dissolution, as the surrounding lung is well preserved, but the tumor cells stain poorly. The outlines of cell walls and the nuclear membrane are indistinct, and the cytoplasm granular.

On the other hand, occasionally even small emboli may be seen in which the actively invasive tendency of the tumor cells is plainly demonstrated. Fig. 6 (No. 18322) shows a small embolus which has apparently lifted up the endothelium from the vessel wall and so given itself a fibrous surface upon which to obtain a footing. Another phase of apparently successful

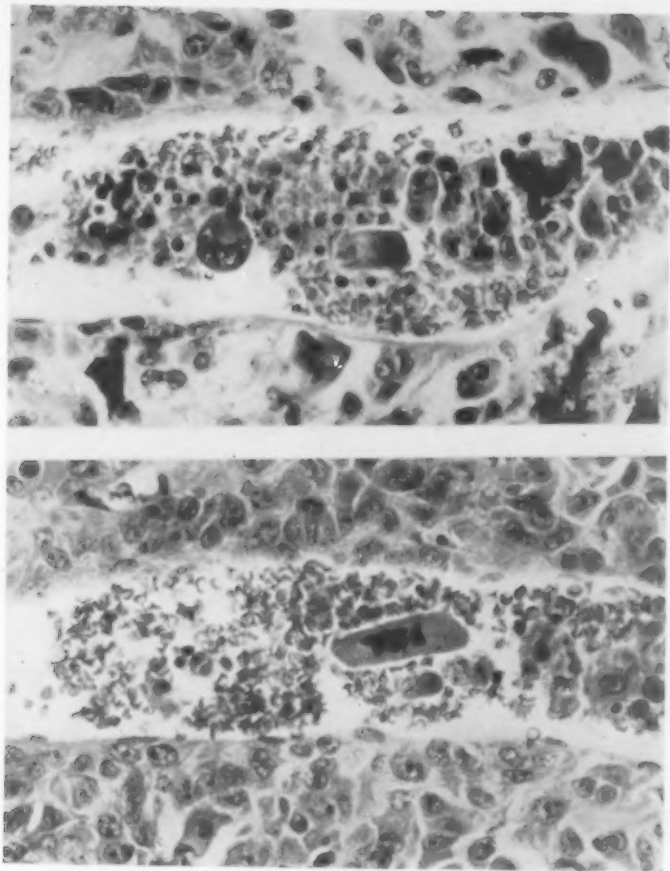


FIG. 11.—(a) Embolus from bone sarcoma in man. Cells are of several types and illustrate early degenerative changes and phagocytosis. (b) Giant cell in blood-vessel in bone sarcoma.

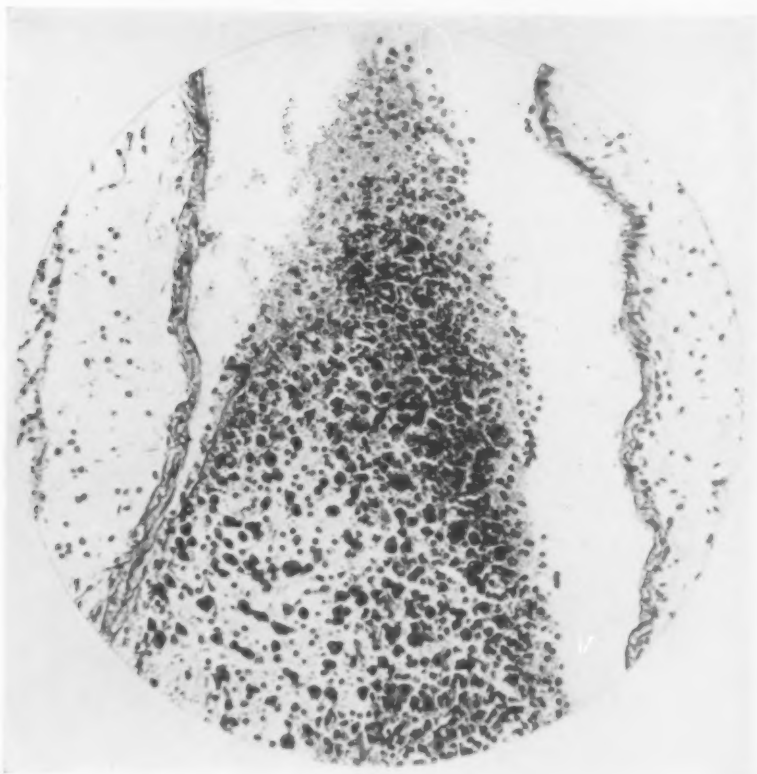


FIG. 12.—Larger tumor embolus in pulmonary artery.

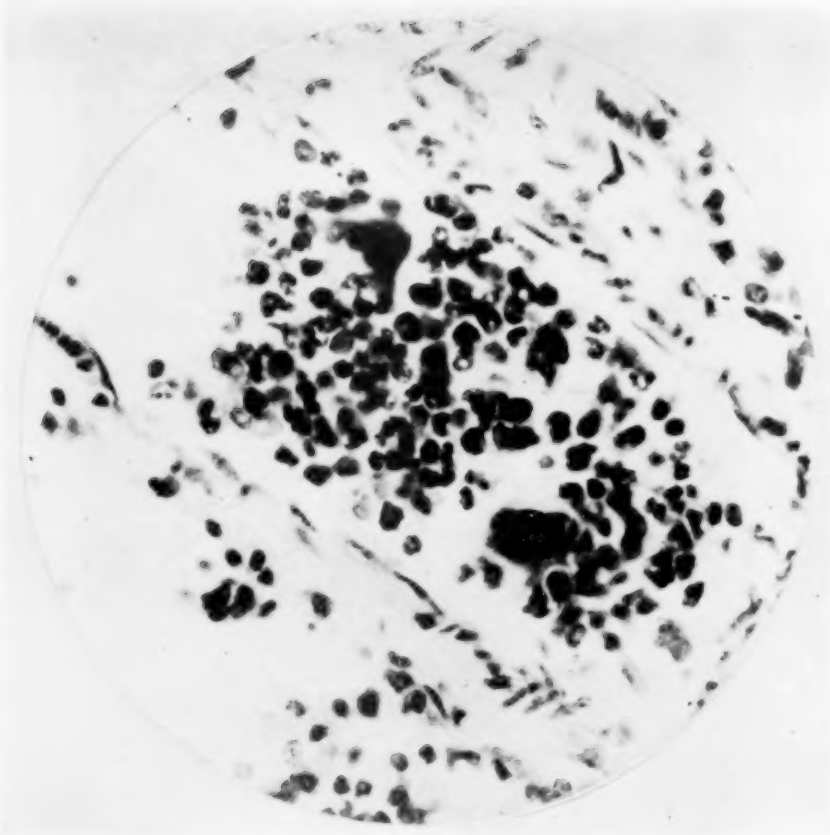


FIG. 13.—Polymorphonuclear cells surrounding a few embolic tumor cells; probably an early stage of thrombus formation.

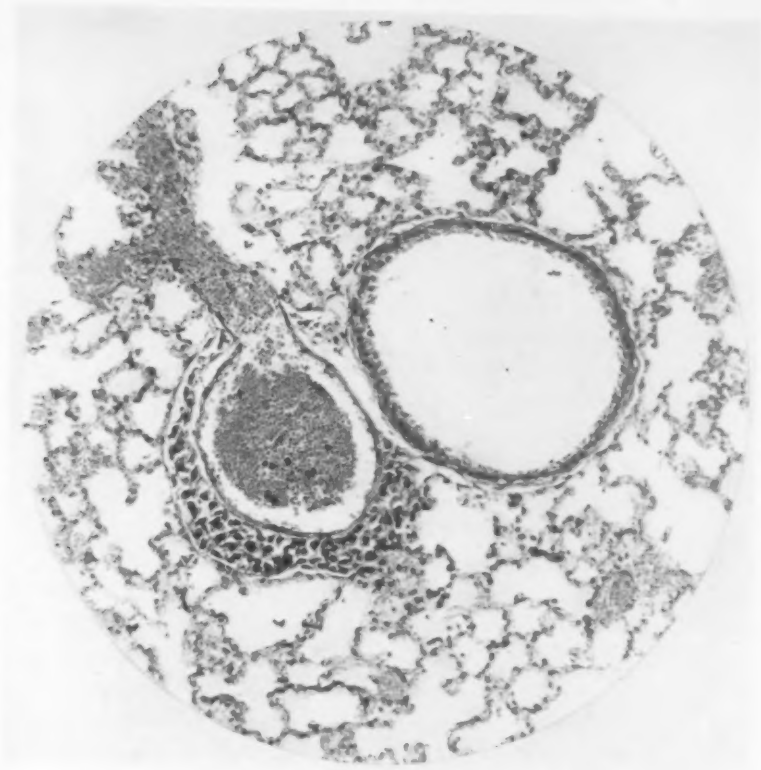


FIG. 14.—Large embolus of tumor cells in perivascular lymph space; probably an extension from a vascular thrombus.

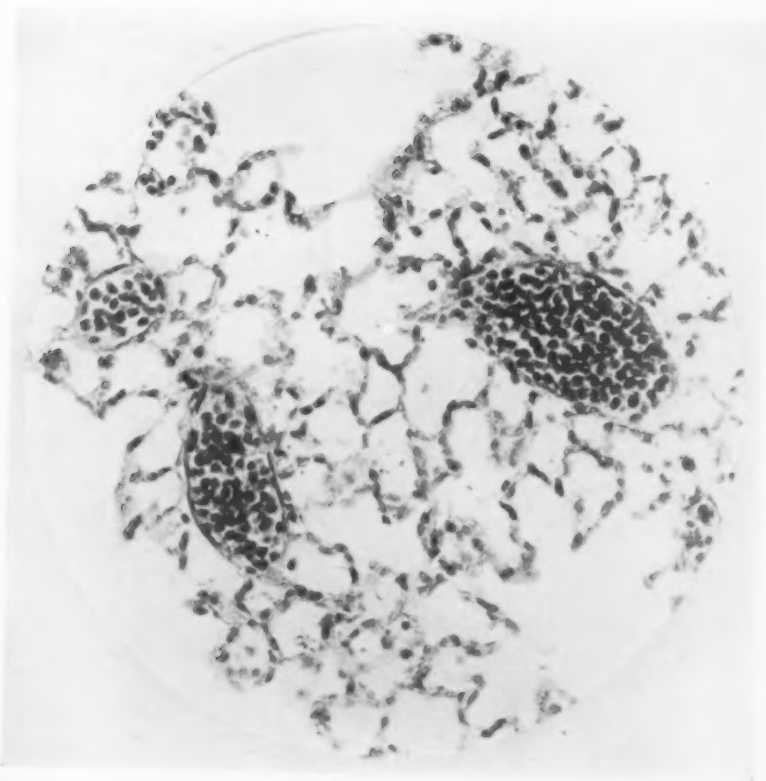
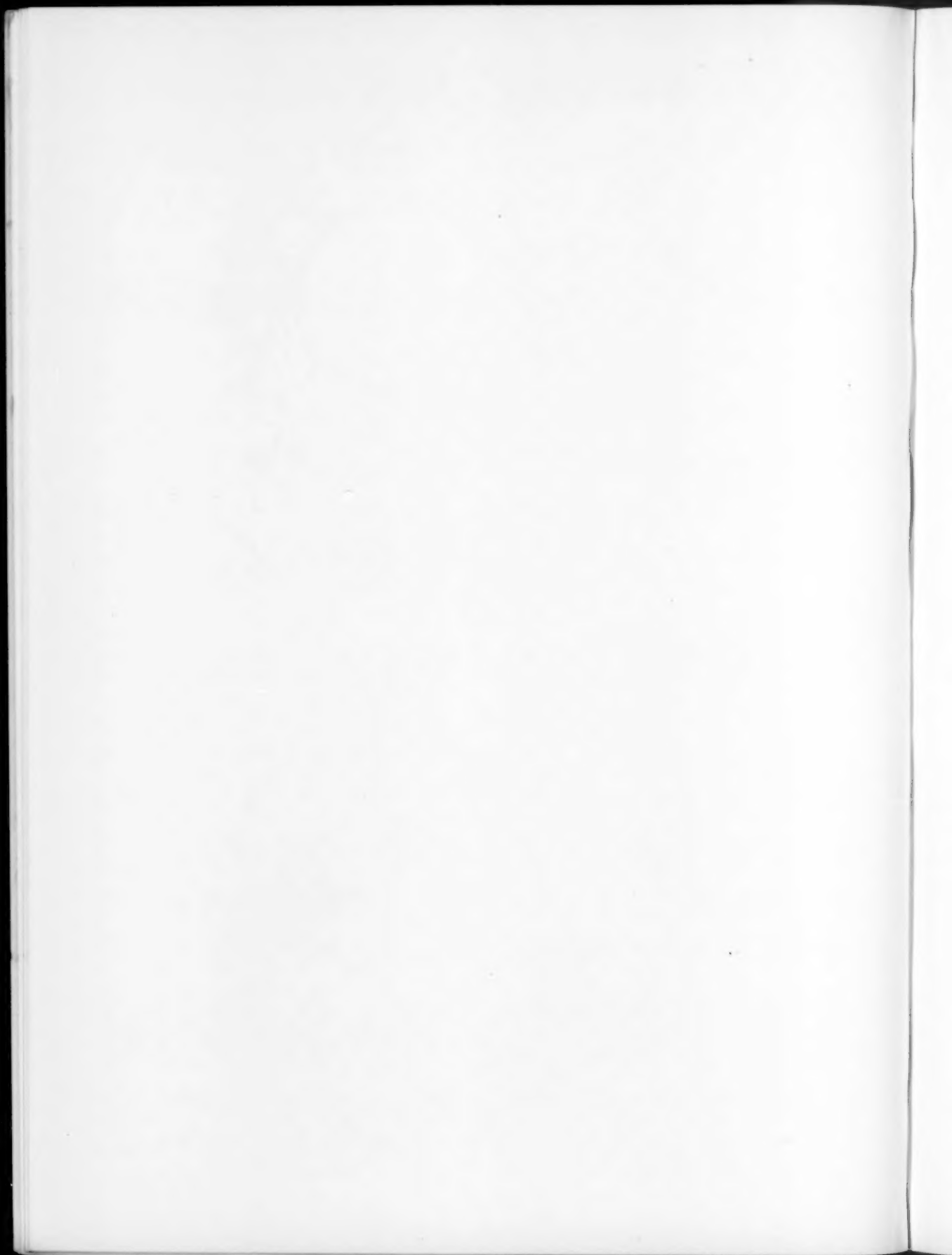


FIG. 15.—Multiple emboli of small cells in pulmonary vessels, possibly tumor cells, but resembling lymphocytes.





## MASSAGE METASTASIS

implantation is shown in Fig. 7 (No. 18343), where a number of well preserved tumor cells are growing in direct continuity with the endothelium. Figs. 8 and 9 show two small pulmonary emboli from a case of carcinoma of the stomach in a human being. In Fig. 8 there is no adhesion of the embolus to the endothelium, although nearly a third of the mass is made up of mucus produced by the epithelial cells; in Fig. 9 one cell only appears to have invaded the endothelium. Another lung furnishes a picture of a more advanced stage of invasion, Fig. 10 (No. 18384). The endothelium can no longer be distinguished, as practically the whole circumference of the muscularis is lined with the tumor cells, and the lumen is almost filled with a carcinomatous embolus in which early degenerative or thrombotic changes have occurred. Similiar parietal thrombi were examined by Schiedat throughout their length and were found to extend for some distance along the surface of the wall and eventually to break through it. The same process is illustrated in Fig. 11 (a) where a large vascular sinus is shown containing many embolic cells from a bone sarcoma in man. The nuclei already show pycnosis, swelling, agglutination by fibrin, and are being surrounded by polymorphonuclear and lymphocytic cells. In (b) is another large blood-vessel from the same tumor with a giant cell among the red blood-cells. This, although of the "endothelial" type and not itself likely to invade other tissues, is of interest in showing that all types of cells may gain access to the blood stream.

That most of the small vascular emboli are derived from larger ones in the main vessel, and not from primary lymphatic involvement, is seen from such an extensive embolus as appears in Fig. 12 (No. 18343), a fairly frequent picture. A very large mass is found in one of the main pulmonary veins and many of its cells are degenerating, the nuclei are pycnotic, and some of the cells have been phagocyted. Figure 13 shows a smaller group of cells surrounded by a thrombotic mass containing many polymorphonuclears, as would be expected in such a situation. It may only occasionally be seen that the cells break into the lymphatics and there grow freely, but it is shown in Fig. 14 (No. 18307). Not infrequently, as in tissues from human beings with tumors, multiple emboli are found in the vessels which may be densely crowded with cells, most of them small, and though hyperchromatic only with difficulty to be distinguished from lymphocytes—in fact, to make a differential diagnosis is very hazardous in spite of the absence of inflammation elsewhere in the section (Fig. 15).

Inspection of Table III shows that among the controls metastases and emboli were coincident only four times in twenty-one animals, or in 19 per cent., while among the massaged this occurred nine times in twenty-five animals, or in 36 per cent. of the cases. The average duration of life was the same in each case. There seems little doubt but that the massage has effected a wider distribution of the tumor even though it is impossible to decide in all the cases just what the ultimate fate of the scattered cells may be, whether they will die or succeed in establishing themselves in the vessel wall.

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On the whole, the polyhedral-cell sarcomata (Crocker Fund No. 180 and Ehrlich mouse sarcoma) seemed just as apt to produce metastases as the carcinomata. In the spindle-cell tumors, metastases are apt to be scanty. This may be explained upon mechanical grounds, from the fact that the cells of most fibro- or spindle-cell sarcomata are more definitely intermingled with and attached to the surrounding connective tissue than in the case of the free-lying cells of the carcinomata. This sustains the view that anatomical relationships of the cells are important in determining metastases.

TABLE III  
Crocker Fund No. 180

Mouse no.	Controls		Mouse no.	Massaged	
	Metastases	Emboli		Metastases	Emboli
18276	2	6	18296	1	
18289	2		18305		3
18300	1		18307	2	3
18302	1		18315		1
18308	1	1	18319	1	6
18321	2	1	18335	2	
18322		6	18370	3	3
18341	1		18372	2	2
18343		3	18373	3	3
18349	1	1	18380	3	3
18352	1		18383	2	2
18355	2		18384	2	6
18363		4	18390	3	
18404	1		18394	1	1
18423	2		18395	2	
18427	1		18399	2	
18433	1		18407	1	2
18480	3		18418	3	
18484		1			
18310	1		18426	3	
18374		1	18428		1
			18446	1	
			18405	2	
			18316	1	
			18323		2
			18334	1	

Total number metastases in controls = 23

Total number emboli in controls = 24

Total number metastases in massaged = 41

Total number emboli in massaged = 38

It would be incorrect, however, to assume that the mechanical factor is of so great importance in determining the ultimate production of a growing tumor as distinct from an embolus as the biological characteristics of the tumor itself. Examination of the chart shows that the correlation between the percentages of total metastases in controls and massaged animals is negative, that is, that those tumors which metastasize spontaneously in a high percentage do not show as great an increase after massage as do those in which spontaneous metastasis is low. For example, the Crocker Fund carcinoma No. 5 shows a smaller increase in its percentage of metastases than does the Flexner rat carcinoma. The same is true of the Ehrlich sarcoma, a strain

## MASSAGE METASTASIS

in which Haaland also found a high percentage of spontaneous metastases; in fact, this writer reports approximately the same percentage of metastases in the twenty-three mice which he observed (60 per cent.) as were seen in the twenty-six animals used in this experiment (58 per cent.).

In these freely metastasizing highly vascular tumors the organism is evidently flooded with emboli before manipulation, and hence many tumor cells may be found in the pulmonary capillaries at all times. Less difference, therefore, can be detected following the massage.

There can be no question under these circumstances that concomitant immunity has any influence on the prevention of appearance or growth of the metastases.

## CONCLUSIONS

1. Study of human material in many ways suggests, but does not finally prove, the importance of massage as a means of inducing metastasis of tumor cells. In animals, on the contrary, very gentle massage for a total period of from two to five minutes, distributed over a number of days, has been shown to set free numerous particles of tumor which form emboli in the lungs.

2. Such emboli produce metastatic tumors in a variable proportion of instances, depending upon the growth activities of the tumor. Tumors which take in low percentages when implanted in the subcutaneous connective tissues give much fewer metastases than those of high virulence.

3. Carcinomata and also sarcomata of the loose polyhedral-cell type are easily generalized, but sarcomata of the compact spindle-cell variety are not influenced.

4. The importance of avoiding diagnostic or operative manipulation of a tumor in man is obvious.

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## TREATMENT OF ERYSIPELAS WITH CHINOSOL AND SODIUM CHLORIDE

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A NUMBER of years ago, the writer determined in cases of erysipelas the presence of bacteria in the subcutaneous fat one inch in advance of the line of demarcation of the erythema, which were there found in greater abundance than in the subcutaneous fat either beneath the line of demarcation, or one inch behind the same. In two out of five cases, cultures taken from the subcutaneous fat at these three sites were all negative, and of the remaining three cases, in two, streptococci were found and in one, diplo bacilli.

Hence a principle in the treatment of erysipelas by topical applications can be laid down, that the area of skin treated should include a wide margin of the normal-appearing skin adjoining the line of demarcation, in order to try and destroy the bacteria which particularly are connected in the spread of the disease. In this work, the boundary of the area to be treated was established by a line about 3 or 4 inches beyond the line of advance of the erythema.

In the writer's earlier experience, erysipelas of the back has always been well-nigh impossible to control by topical applications, so that when a remedy is found, as here demonstrated, whose use has been followed by the arrest of erysipelas in this locality in a fair proportion of these cases, this remedy would seem to possess a distinct worth for the treatment of erysipelas.

The chinisol preparations employed were two in number, one an ointment and the other a tincture.

The formula for making the chinisol ointment is as follows:

R  
Aque dest. (cold sterile), 3ss  
Add and dissolve  
Pulv. chinisol grs. x  
Then add  
Sod. chloride (reagent) grs. iv  
Rub up, first with  
Lanolin 3ss  
Finally incorporating  
Vaseline (white) 3ss  
M. et Sig.—Chinisol ointment.

*The Chinisol Ointment.*—The chinisol ointment while applicable for use in the treatment of erysipelas affecting any skin area of the body was generally used for all parts of the body only in children, its use in adults being generally limited to the face and ears. The advantages of the ointment over the tincture in the facial cases were, that it could be applied more easily



to the irregularities of the face and ears and that it could be used on the eyelids without much danger of its getting into the eyes, the latter occurrence, though highly undesirable, being one of seeming minor significance in the case of the ointment.

NOTE.—The chinol ointment is also of great value to abort beginning hair-follicle infections (rubbed gently in for two or three minutes and repeated, if necessary, in two or three hours). It is useful for healing abrasions, small, healthily granulating ulcers, chapped hands, insect bites (relieves the itching) and stings. A prior ointment containing chinol, grs. vi, and sodium chloride, grs. ii, to half an ounce each of lanolin and vaseline, has been found healing for second degree burns, and it is thought that the present ointment would be equally efficacious and non-irritating for this purpose.

The formula until March 23, 1921, called for  $\text{Si}$  of water as the solvent of the chinol and sodium chloride in  $\text{Si}$  of the ointment, but in order to stiffen the ointment and to cause a more ready taking up of the ingredients by the lanolin, the lesser amount of water ( $\text{Sss}$ ) was substituted. The addition of sodium chloride to chinol in aqueous solution produces in the evaporated specimen a crystallization different from that seen in an evaporated specimen of a solution of chinol alone, the characteristic features of which are, the formation of radiating or diverging rods and, where there are open spaces, needle-like projections. This transformation in the crystallization of the chinol has seemed in some way to be associated with a lessening of the irritative properties of chinol. Thus, in days gone by, before sodium chloride was combined with chinol, the largest amount of chinol that could be used in the ointment without causing irritation, was grs. vi to the ounce, the use of an ointment containing grs. viii or grs. x to the ounce on a skin surface at that time, soon having caused excoriation of the cuticle. The present ointment, however, has caused not the slightest irritation when applied *per se* to normal or inflamed skin in the treatment of the erysipelas cases. Therefore in making up the ointment, it has seemed important to first combine the sodium chloride with the chinol in a minimum amount of water, before these ingredients are incorporated into the lanolin, so as to fully establish at the outset the change which takes place in the chinol as a result of thus combining it.

This ointment, however, if thin enough, may run into the eyes and cause therein a little burning sensation, and in two such instances (Cases Nos. 34 and 35) the ointment apparently was the cause of a vascular injection of the sclera. Also in an instance of marked swelling of the conjunctiva (Case No. 65) the ointment may have been the etiological factor. These eye irritations rapidly cleared up with the application of boric acid compresses. Hence the lanolin used should not have too thin a consistency.

*The Tincture of Chinol.*—The tincture of chinol was found serviceable for use in cases of adult erysipelas of the scalp, where it could be readily run in among the hair roots, as well as in cases of adult erysipelas of the trunk and extremities, where considerable areas were generally involved,

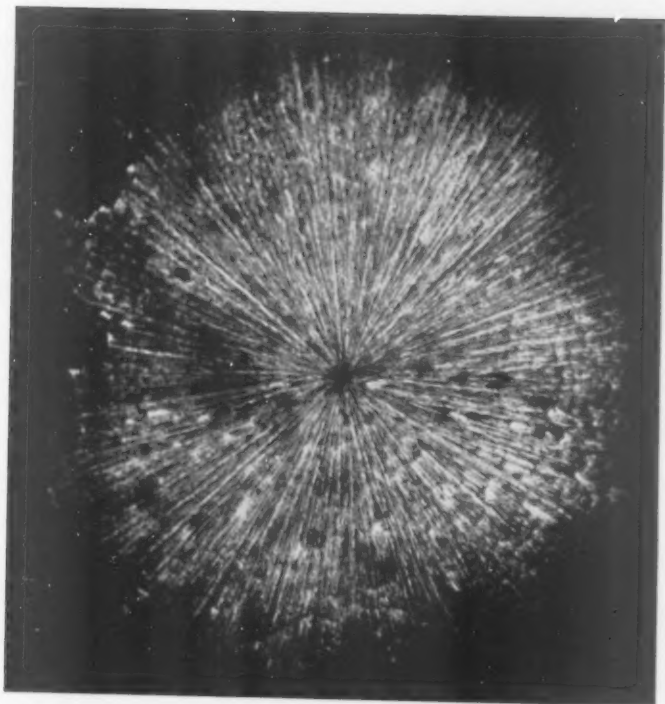


FIG. 1.—Crystallization of the tincture of chinosa containing sodium chloride. Sunburst type (usual). The crystallization is quite different when the sodium chloride is not combined with the chinosa.

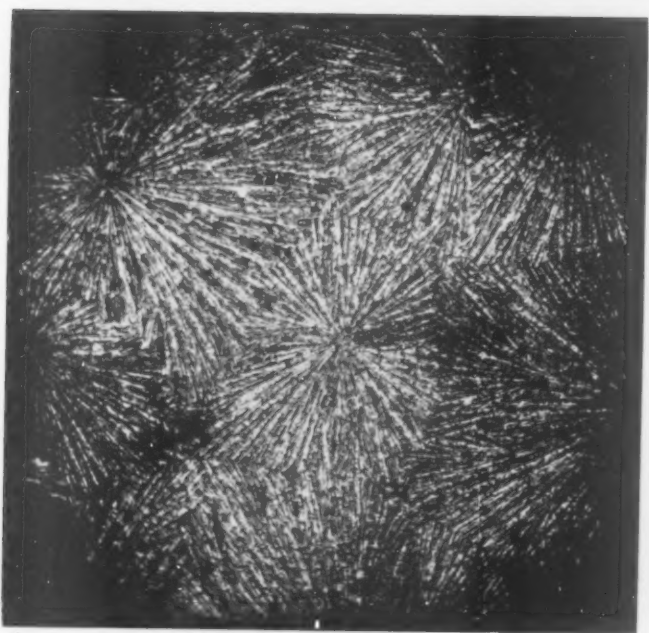


FIG. 2.—The tincture of chinosa. Interlocking systems of radiating rods. (usual).

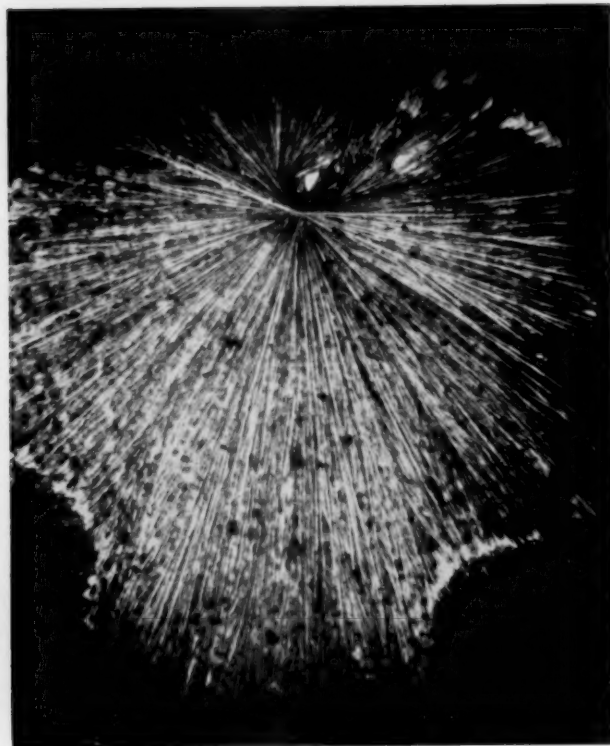


FIG. 3.—The tincture of chincol. Rods, diverging fan-shaped (a usual type but an unusual pattern).



FIG. 4.—The tincture of chincol. Diverging rods splitting apart to form a lacework (usual).

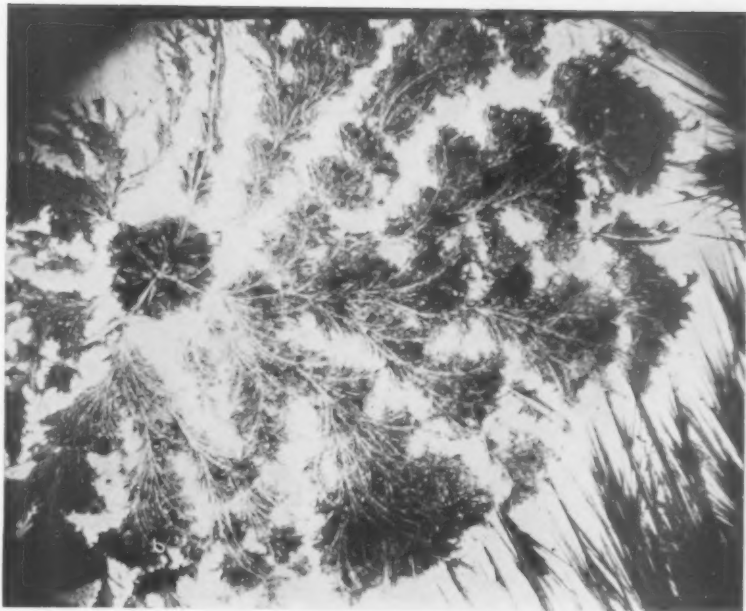


FIG. 5.—The tincture of chinosol. Curvilinear branching yellow stalks with masses of irregularly disposed yellow crystals among the branches. (This type of crystallization is often found in small quantity.) This pattern is thus far unique. Projecting needle crystals at upper margin.

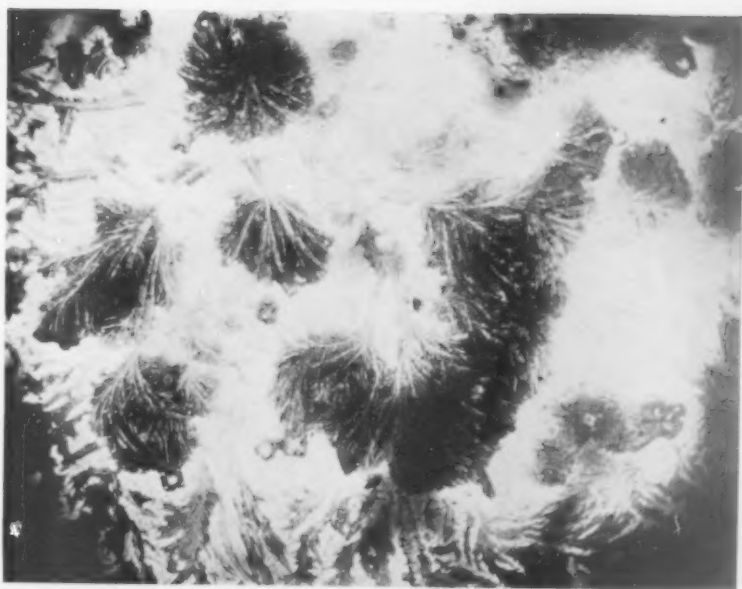


FIG. 6.—The tincture of chinosol. The usual appearance (fragments of the type of crystallization shown in Fig. 5).



FIG. 7.—The tincture of chinosol. Irregular elongated yellow islands with pinkish translucent straight lines in their long axes from which arms project laterally which are parallel to each other, two lines often intersecting to form the figure of a cross (unusual crystallization).

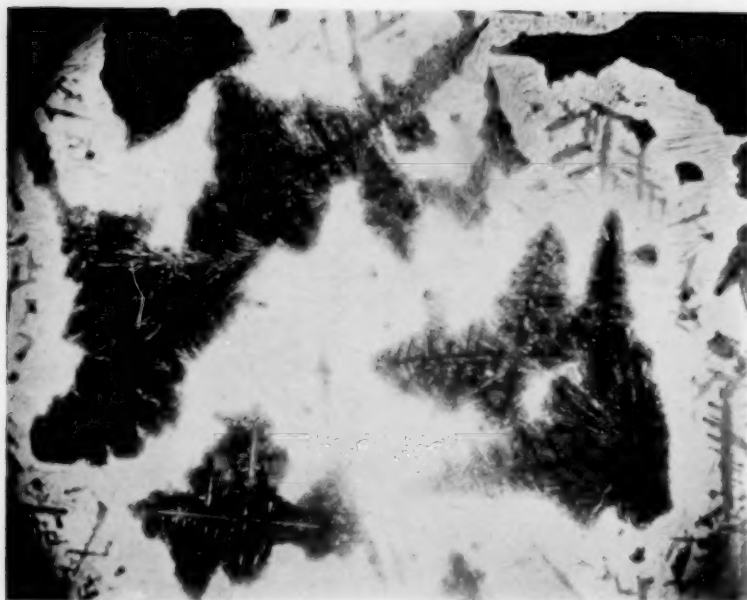


FIG. 8.—Similar to Fig. 7.



## TREATMENT OF ERYSIPELAS WITH CHINOSOL

whose painting with the tincture with a camel's-hair brush could be more readily accomplished than could the application of the ointment.

The formula for making the tincture of chinisol is as follows:

<b>R</b>	
Aque dest. (10 parts)	℥iss m xlvi
Boil and make cold in ice-box	
Then add and dissolve	
Chinosol powder (2½ per cent.)	grs. cxcii
Then add	
95 per cent. alcohol (70 parts)	℥xi ℥i m xxxvi
Shake and add	
Acetone (20 parts)	℥iii ℥i m xxxvi
Shake and add without delay, because otherwise a precipitate of chinisol will soon begin to form	
Sodium chloride (reagent)	grs. xcvi
Shake vigorously five to ten minutes	
A flocculent precipitate will now form which soon redissolves	
The insoluble residue is sodium chloride	
Let stand over night and then strain through sterile cotton.	

Sig.—Tincture chinisol with acetone and sodium chloride.

NOTE.—This tincture of chinisol has also been useful, by painting it on a skin surface, to reduce inflammatory swelling extending to a distance from a focus of infection; painted on freely once in four hours, it has seemed of avail in two or three cases of phlebitis; it has allayed eczema in a few cases, relieving the itching, and has relieved itching in a case of shumack poisoning. Painted on a granulating ulcer and the adjoining skin, and the ulcer then strapped with ZnO adhesive plaster, once in two days, it stimulates epithelial growth. Painted on the skin around a discharging boil, it prevents further hair-follicle infection. Also painted on the skin once in four hours, it has checked lymphangitis.

In making up the tincture of chinisol, the glass receptacles and utensils used, should be scoured with neutral sodium oleate and should then be boiled in plain water. An alkali will precipitate oxyquinolin from the chinisol (oxyquinolin sulphate), so that soda should not be put into the water used for boiling. Nor should the glass be treated with hydrochloric acid. A glass vessel is preferable to an enameled one as a container, since spots of bare iron, usually present in the latter receptacle, will discolor the chinisol. For the same reason any tin in the make-up of a camel's-hair brush should be cut away and the hair of the brush simply bound with a thread to a stick for a handle.

The acetone, in the proportion here used, is capable of dissolving but a very small amount of grease, but it probably facilitates penetration into the hair follicles, and, under ordinary conditions of weather, it hastens materially the time of evaporation of the tincture. In very humid weather a specimen of this tincture poured on a glass slide will not completely evaporate, the liquid which remains evidently being the water content of the tincture, the evaporation of which is apparently prevented under these circumstances by the presence of the sodium chloride. Yet in humid weather the tincture will be taken up by the skin nevertheless.

The addition of the sodium chloride as a component in the tincture of chinisol causes a considerable flocculent whitish precipitate to be thrown out, which on microscopic examination is seen to consist of fine needle-like crystals, which soon go into solution, leaving no undissolved chinisol, but there remains a large residue of sodium chloride. Since without the addition of the sodium chloride a considerable amount of the yellow chinisol powder would speedily precipitate out of the alcoholic solution, it can be seen that the addition of the sodium chloride produces some change in the chinisol which renders it more soluble. If before the addition of the sodium chloride, yellow chinisol has already precipitated out, with the addition of the sodium chloride and shaking of the mixture, the yellow chinisol will redissolve. As, in the aqueous solutions of chinisol, the addition of sodium chloride alters the crystallization, so, in the tincture the sodium chloride transforms the picture of crystallization usually into one of many interlocking systems of rods radiating from centres, which produce the effect of many sunbursts (Figs. 1 and 2). If the later stages of crystallization of the tincture be observed under the microscope, these rods can be seen to be laid down by actual growth from the centres of the systems, they elongating very rapidly in this quickly evaporating fluid, until those of adjoining systems come clashing together and interlock. The picture may, as well, be one of rods diverging fan-shaped (Fig. 3), often splitting apart to form a lacework (Fig. 4). Another variety of crystallization often found in small quantity in this tincture is one which, when the deposit is thin, can be seen to consist of narrow, coarsely granular translucent yellow, branching stalks, the latter curvilinear in outline, the branches generally arching laterally from the stalks and supporting thick masses of irregularly arranged elongated, yellow crystals, which project in jagged formation at the margins (Fig. 5). Where the deposit is thick, translucent yellow stalks stand out more or less prominently in the midst of darkened areas interspersed among them (Fig. 6). Occasionally the evaporated specimen of the tincture presents irregularly elongated yellow crystalline islands, in the long axis of each of which a clear translucent straight line, usually pinkish in color, runs, from either side of which arms may project nearly perpendicularly, which are parallel to each other, two lines often intersecting to form the figure of a cross (Figs. 7 and 8). Thus an examination of the crystals can readily determine whether or not this tincture contains the correct product, and should be made use of to guard against error.

Crystallized chinisol, untransformed by sodium chloride, may present little greenish-yellow islands, finely granular, bordered with a network of ropes or flagellæ, or else stretches of the same greenish-yellow formation interspersed with open spaces into which bordering flagellæ project; or there may be a finely granular brownish deposit; or, sometimes the chinisol is deposited, apparently most often out of alcoholic solution, in patterns of clear translucent yellow and dark brown, the latter areas changing on deeper focussing to translucent pink.

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It was of interest that, while sodium chloride is but little soluble in alcoholic solution, nevertheless, in order to get mostly all crystals of the sunburst or the diverging rod patterns, which apparently represent the highest degree of transformation of the chinosol, it was necessary to add as much as grs. vi of sodium chloride to the ounce of the tincture, which amount is in large excess of that which is readily soluble in this tincture. In the crystallized specimen of this tincture a rather limited number of salt cubes are seen. With the use of a greater amount of sodium chloride (grs. x- $\bar{3}$ i) a greater number of salt cubes were found in the crystallized specimens, which increased quantity was thought to be an element possibly unfavorable for the absorption of the chinosol through the skin. In the making up of the tincture here described, the sodium chloride (grs. vi- $\bar{3}$ i) should be added last of all, with which technic, the resulting flocculent precipitate goes most rapidly back into solution, also the transformation in the crystallization of the chinosol is then more completely into the sunburst and diverging rod types (*i.e.*, with little or no substratum layer), which crystals are regarded to indicate the highest degree of transformation, and the number of sodium chloride cubes found in the crystallized specimen has seemed to be very few in number. When the sodium chloride was added to the aqueous solution of the chinosol preceding the alcohol and acetone, the precipitate which formed on adding the alcohol did not dissolve for a number of days, and a much greater quantity of sodium chloride cubes was found in the crystallized specimen.

This tincture, as well as others, in which the chinosol was always in the same proportion ( $2\frac{1}{2}$  per cent.), but the proportions of alcohol, acetone and sodium chloride varied a little, applied freely to the skin three times a day and twice at night, has never been observed to cause any skin irritation, either when used alone or when preceded with an ether wash. At one time when the tincture of chinosol was being generally used on all the erysipelas cases, nurses who were applying this lotion on cotton with their bare hands, going from case to case three times a day, sustained no ill effect whatever. Nor was any evidence of skin irritation observed in a few young children and infants on whom it was used five times in the twenty-four hours, though the babies always cried when it was being painted on them, and so the ointment was substituted for general use in children. Only once has this tincture been known to irritate a skin surface, and that was when it was applied to the latter on gauze which was covered with rubber tissue. On the other hand, a tincture of about 2 per cent. chinosol with acetone having no sodium chloride constituent, when applied to the skin following an ether wash, caused much smarting, and after a very few applications excoriation of the cuticle ensued. Without the preliminary ether wash, the latter tincture could however be applied to the adult skin freely twice a day for some time without causing irritation. Thus it can be said that the sodium chloride in the tincture of chinosol here described, acts in some way upon the chinosol, in addition to increasing its solubility, to render it practically non-irritating, the accompanying change in the crystallization probably being of associated significance.

*The Treatment.*—The work was done in the erysipelas ward of Bellevue Hospital, in the rush of a large and exacting service. The cases here enumerated were admitted in the period from February 10, to March 25, 1921.

The routine treatment consisted in the use of the chinosol ointment for all adult cases of facial erysipelas and for erysipelas affecting any part of the body in children, and the use of the tincture of chinosol, preceded (after March 9th) by a wash of the skin surface with ether, for all adult cases of erysipelas of the scalp, trunk and extremities. Treatments were administered three times during the day, at four-hour intervals, and twice at night. In cases of facial erysipelas, eyelids which had not swelled were always anointed from the start, just the same as the swollen lids, with the intent to forestall swelling. Owing to the fact that bacteria had been found by the writer in considerable abundance in the subcutaneous fat beneath the normal-appearing skin one inch in advance of the line of demarcation of the erythema, the area treated included a belt of the normal-appearing skin, three or four inches in width, adjoining the line of demarcation.

*The technic of applying the ointment* was by gently smearing it over the skin surface, its disinfectant action on the tissues probably being more effectual when spread somewhat thickly rather than thinly. The eyelids, however, should, with intention, be but sparsely covered with the ointment, with a view of preventing the latter from getting into the eyes, which occurrence is more likely to happen in warm weather, when the consistency of the grease is lessened. An excessive amount of ointment on the eyelids should be wiped off with cotton. The best applicator for spreading the ointment over the irregularities of the face was a wooden tongue-depressor, which was serviceable as well for applying the ointment to other parts of the body. For rapidity of action the ointment was at times swabbed over the skin surface with a piece of gauze, with which procedure, however, care should be taken not to use too much force.

*The Technic of Use of the Tincture.*—It seemed that, in the treatment of erysipelas of the scalp and back with the tincture of chinosol, it was of considerable importance, in the attempt to effect control of the disease, to precede the application of the tincture with an ether wash, so that after March 9th this technic was put into general practice for the treatment for all skin areas affected with erysipelas. The ether should be applied with cotton, which it should fully saturate, the skin being gently washed with the same, after which the tincture should be painted on freely, most readily done with a large camel's-hair brush, in several successive layers as drying of each occurs, which takes place rapidly. In applying this technic to a hairy scalp, cotton was the best medium for bringing the ether, which should saturate it, against the skin of the scalp, which is done by sopping the ether out of the cotton into the hair and working the ether-soaked cotton gently around over the hair against the scalp, with the fingers, which comes as near as it is possible to wiping the surface of the scalp. The tincture of chinosol should then follow, either by pouring it into the hair, or else sopping it on



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bountifully with the large camel's-hair brush, and then perhaps working it very gently around the hair roots with the tips of the fingers. Both the ether and the tincture should be used liberally. In making these applications to the scalp, the eyes should be protected with gauze. The cheaper sulphuric ether for skin cleansing serves every purpose.

The best results with this technic seemed to be obtained when time could be taken to allow a number of superimposed layers of the tincture of chinosol to evaporate one after the other on the skin surface, which, besides causing a larger deposit of chinosol, probably ensures as well a deeper penetration of the same into the hair-follicles. The presence of the acetone makes the taking up of this tincture by the skin very rapid. In the treatment of erysipelas spreading from a wound which had to be covered with a dressing, as in the case of operative wounds of the mastoid, the tincture was readily applied to the affected skin beneath the dressings by sopping it into the dressings at the appointed times, no irritation having resulted from this technic. It was also found that ichthyol and collodian, tightly adherent to tender areas of skin affected with erysipelas, could be readily removed by washing the areas with this tincture of chinosol.

When erysipelas of the face, treated with the chinosol ointment, involves the forehead or the ears, the adjoining normal-appearing scalp should, without any delay, be treated with ether and the tincture of chinosol, in order to try and destroy the bacteria lying in the tissues around the hair line in advance of the inflammatory zone, just the same as the skin area beyond the erythema is treated in other parts of the body.

*The Results.*—The test of the efficiency of the treatment was sought in the control of the spread of the erysipelas and not in the control of the temperature, which latter would frequently rise to a high point and fall, without any apparent extension of the disease, particularly in cases with much swelling. In cases with much swelling, with no spread of the erysipelas, it has seemed a foregone conclusion that the temperature was going to have a daily rise nevertheless, until the swelling had reduced.

The cases comprise:

### I. Adult erysipelas of face and scalp treated with the chinosol ointment and the tincture of chinosol, respectively.

	Per cent.
(a) Cases without spread after admission	24 (33.8)
(b) Cases without recorded observation on second day, which afterward had no spread	3 ( 4.2)
(c) Cases which showed spread only on second day	7 ( 9.9)
(d) Other cases which had but one day of spreading	4 (5.6)
(e) Cases without recorded observation on second day, which afterward had but one day of spreading	3 ( 4.2)
(f) Cases having two days of spreading	6 ( 8.4)
(g) Cases having three days of spreading	9 (12.7)
(h) Cases having more than three days of spreading	7 ( 9.9)
(i) Cases having recurrence during treatment	4 (5.6 per cent.)
Less cases included in Class (h)	2
	—
	2

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(k) Cases of recurrence following primary subsidence	2 (2.8)
Less cases included in class (h)	1
	—
(l) Miscellaneous	2 ( 2.8)
(m) Died	3 ( 4.2)
	—
Total	71
II. Adult erysipelas of extremities treated with the tincture of chinisol.	
(a) Cases without spread after admission	4 (50 )
(b) Cases having one day of spreading	3 (37.5)
(c) Case having three or four days of spreading	1 (12.5)
	—
Total	8
III. Children's erysipelas of face treated with the chinisol ointment.	
(a) Cases without spread after admission	6 (75 )
(b) Cases having three days of spreading	2 (25 )
	—
Total	8
IV. Children's erysipelas of trunk and extremities treated generally with the chinisol ointment.	
(a) Case without spread after admission	1 (12.5)
(b) Case having one day of spreading	1 (12.5)
(c) Case of early recovery	1 (12.5)
(d) Case having two days of spreading	1 (12.5)
(e) Case with twelve days of spreading	1 (12.5)
(f) Died (one recurrence)	3 (37.5)
	—
Total	8
	—
Grand total	95

The important facts regarding each of these cases are given in the accompanying tables.

Three cases of pneumonia with facial erysipelas, two of them infants, who died on the second or third days after admission, were omitted from this series, since they were essentially cases of pneumonia, as well as several cases of recurrent erysipelas whose primary attacks had not been treated by the technic herein outlined.

Two of the deaths in Group I (adult erysipelas of face and scalp) resulted from pneumonia, and one from cedema of the glottis.

Two of the cases in Group IV (children's erysipelas of trunk and extremities), who died, were infants who suffered from malnutrition, and the third case who died, aged fifteen months whose erysipelas ran its course for three weeks, suffered from anæmia and cervical adenitis.

Record was made each morning at rounds on a general chart containing the names of all the cases, as to whether or not spread had taken place since the preceding morning. It was not always possible to determine on the morning of the second day whether or not spread had taken place since admission of the patient to the hospital, nor was it considered very disparaging to the method of treatment where a single spread of the erysipelas took place between the time of admission and the morning of the second day, since the



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remedies would then have had only a short space of time in which to have gotten in their effect. Thus the cases of classes *b* and *c* of Group I, which had a possible or actual spread of the erysipelas on the second day only, might be added to those of class *a* in the same group, to support the argument in favor of the serviceability of this remedy to control erysipelas in a considerable proportion of the cases.

In an acute case of erysipelas with much swelling and tension, treated as herein described, the original swelling would very soon begin to reduce and if no extension took place, the patient would thereupon be made more comfortable. If spread occurred, however, then pain would affect the newly invaded area.

In an extensively spreading case, with this treatment, the areas primarily affected become healed and normal in appearance as the advance takes place. Thus erysipelas of the face and scalp has been seen to become healed as the disease has spread down the back, while the erysipelas of the trunk will in turn heal as spread therefrom takes place down the extremities, sometimes in the latter situations the erythema forming simply a narrow strip, or a cuff from one or two to a dozen inches in length, from the lower margin of which, the advance proceeds.

With the use of the chinisol ointment for the treatment of facial erysipelas, the early reduction of the swelling of already swollen eyelids, and the occurrence of but a comparatively small amount of swelling in eyelids which became swollen after admission, were noticeable features, there having been but little tendency for the eyelids to suppurate (but one eyelid—Case No. 29—in seventy-one cases of adult facial and scalp erysipelas).

Since chinisol *in vitro*, while a powerful antiseptic, is but little germicidal, it would seem not at all improbable that its ability to disinfect vitalized tissue, the truth of which has been demonstrated by the writer,\* was due to a power to stimulate phagocytosis. If this supposition be true, then, other things being equal, the variation in response of some of the cases of erysipelas to the method of treatment here described, would seem explicable on the ground of varying degrees of resistance among the cases, with corresponding variation in response of their tissues to the supposed phagocytic stimulus.

A cure of the erysipelas was regarded to have taken place on the subsidence of the inflammatory swelling and the fading of the distinctive erythema, accompanied, in cases having no other febrile condition, with a drop of the temperature to normal without subsequent rise. Some of the cured cases who were discharged on the second consecutive day of normal temperature were given a small box of the chinisol ointment to use at home. But two discharged cases (Nos. 65 and 66) in this series returned with recurrences, one of which was afebrile.

Four cases of facial erysipelas (Class *i*, Nos. 61 and 64) suffered recur-

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\* Lusk. "The Disinfection of Vitalized Tissues and the Healing of Wounds with Chinisol and Salt" (A Foreword). *ANNALS OF SURGERY*, 1919, pp. 493-497.

TABLE I  
Adult Facial and Scalp Erysipelas Treated with Chinocol Ointment and the Tincture Respectively.

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of Spread	Estimated Duration	Sequels	Result
(a) Cases without spread after admission										
1.	N.H.	47 m.	Post-op. mastoid right; alcoholism; D. T's.	3	Facial with marked swelling		0	10th day. Temp. drop normal w'out subseq. rise		15th day Dis. C.
2.	D.M.	21 m.		2	Entire face. Eyes almost closed		0	3d day. Drop to normal & thereabouts (99.4)		9th day Dis. C.
3.	J.D.	37 m.		3	Entire left face involving scalp & crossing nose		0	5th day. Drop normal w'out rise		9th day Dis. C.
4.	A.H.	19 m.		3	Nose, eyelids, forehead. Eyes wide open		0	Highest temp. 99.8		3d day Dis. C.
5.	C.L.	24 m.		6	Chin		0	3d drop normal w'out rise		5th day Dis. C.
6.	C.O.	42 fem.		1	Face incl'g. forehead		0	8th drop normal w'out rise		11th day Dis. C.
7.	J.K.	58 m.		3	Right cheek, ear & nose		0	3d day. Drop normal w'out rise		7th day Dis. C.
8.	H.R.	45 m.	Febrile condit. Cardiac. Nephrit.	1	Left cheek & nose		0	6th day. Erys. condit. clear		6th day Dis. Erys. C.

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9.	A.A.	45 m.		4	Both cheeks & nose		0	8th. Drop ar. normal w'out rise		11th day Dis. C.
10.	A.S.	28 fem.		5	Cheeks, ears forehead & scalp	Scalp ether & tinct. Face oint.	0	5th day. Drop normal w'out rise		8th day Dis. C.
11.	W.H.R.	68 m.		4	Entire face. Eyes partially closed		0	6th day. Drop normal w'out rise		9th day Dis. C.
12.	P.F.	50 m.	Scalp wounds. Alcoholism	2	Scalp and neck	Tincture	0	3d day. Drop normal w'out rise		4th day Dis. Erys. C.
13.	D.B.	50 m.	Heavy drinker	2	Lt. cheek & eye-lids. Lt. eye closed		0	4th day. Drop normal w'out rise		6th day Dis. C.
14.	C.M.	57 m.	Over indulgent drinker. Sl. eye irrit. 1/2 hr. fr. ch. 5th day.—Gran. wd. rt. eye socket	2	Forehead & skin abt. orbits. Left eye closed		0	3d. Drop normal with rise to 99.2		6th day Dis. C.
15.	M.S.	40 fem.	Obesity	8	Entire face, ears & part of scalp. Eyes partially closed.	Ointment	0	3d. Drop normal w'out rise		6th day Dis. C.
16.	J.F.	37 m.		8	Rt. side face & neck. Eye partially open		0	2d. Drop normal w'out rise		6th day Dis. C.

TABLE I—(Continued)  
*Adult Facial and Scalp Erysipelas Treated with Chinoid Ointment and the Tincture Respectively.*

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of Spread	Estimated Duration	Sequels	Result
(a) <i>Cases without spread after admission</i> (Continued)										
17.	S.L.	49 m.	Heavy drinker. Corpulency	6	Face incl'g. forehead		0	6th. Drop normal w/out rise		7th day Dis. C.
18.	T. McG.	54 m.		5	Nose, forehead & molar regions Eyes open		0	5th. P.M. drop normal w/out rise		6th day Dis. C.
19.	H.L.	46 m.	Cellulitis behind right eyebrow	7	Face		0	3d. P.M. drop normal with slight rise (99.6)		8th day Dis. Erys. C.
20.	J.R.	22 m.		3	Nose, eyes, cheeks & forehead. Eyes not closed		0	5th. Drop normal w/out rise		6th day Dis. C.
21.	J.M.	18 m.		4	Left face (vesicated)		0	4th. Drop normal w/out rise		5th day. Dis. C.
22.	C.H.	45 fem.		4	Nose & adjoining cheeks		0	2d P.M. drop to ar. 99° (lasting) 5th 100.4°		6th day. Dis. C.
23.	K.P.	36 m.		4	Face markedly swollen. Eyes closed		0	4th. Drop normal w/out rise		5th Trsf'd. Erys. Contr'd 9th day Dis. C.

# TREATMENT OF ERYSIPELAS WITH CHINOSOL

24.	G.B.	47 m.	3	Left ear & side of neck	0	3d day. Drop normal without rise	4th day. Dis. C.
(b) Cases without recorded observation on 2d day which afterward had no spread							
25.	A.K.	63 m.	6	Face, incl'g ears. Eyes nearly closed	2d. No observation otherwise 0	Temp. low 3d. Drop normal essent'ly w/out rise 5th 99.6	6th day. Dis. C.
26.	M.McN.	67 fem.	5	Entire left cheek & eye-lids. Eyes partly closed	2d. No record. Otherwise 0	2d. drop normal w/out rise	8th day. Dis. C.
27.	D.J.	28	?	Left face. Eye not closed	2d. No record & no oint. Oth- wise 0	4th. Drop normal w/out rise	8th day. Dis. C.
(c) Cases which spread after admission, only on 2d day							
28.	M.G.	52 m.	1	Face, left side	2d day—fore-head	3d. Drop normal w/out rise	5th day. Dis. C.
29.	H.C.	51 m.	4	Face, incl'g lids of both eyes & forehead	11 to 13 days (inclusive) treat. interrupted following a 2 day drop temp. to normal	16th. Drop normal w/out rise	18th day. Dis. Erys. C.

TABLE I (Continued)  
*Adult Facial and Scalp Erysipelas Treated with Chinosol Ointment and the Tincture Respectively.*

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of Spread	Estimated Duration	Sequels	Result
30.	T.B.	40 m.		3	Face, incl'g. forehead. Eyes nearly closed. Vesicles	Face & scalp (bald) treat. up to 10th day with oint.	2d day to scalp	5th. Drop normal w/out rise		11th day. Dis. C.
31.	S.B.	53 fem.	Corpulency	3	Entire face incl'g. forehead		2d day	3d. Drop normal w/out rise		5th day. Dis. C.
32.	P.T.	31 m.		4	Left eyelids, forehead, scalp & neck	Face, oint. Scalp, ether & tinct.	2d day	5th. Drop normal w/out rise		9th day. Dis. C.
33.	W.M.	37 m.		4	Rt. face & scalp excepting eyelids	Scalp, ether & tinct. Face, oint.	2d day	7th. Drop normal w/out rise		12th day. Dis. C.
34.	M.C.	40 fem.	Rt. eye irritated 4th day	3	Lt. face, ear & scalp. Eye closed	Ointment	2d to rt. side face	5th. Drop normal w/out rise		10th day. Dis. C.
(d) Other cases which had but one day of spreading after admission										
35.	M.R.	48 fem.		2	Left face incl'g. forehead		4th day scalp	7th. Drop normal w/out rise		11th day. Dis. C.
36.	T. McC.	60 fem.	Senility	2	Nose & adjoining face (butterfly)		4th ear (w/out elev. temp.)	2d. Drop normal w/out rise		11th day. Dis. C.



# TREATMENT OF ERYSIPELAS WITH CHINOSOL

37.	O.N.	65 m.	5	Rt. face incl'g. forehead, extending to left	4th scalp	8th. Drop normal until 14th, 99.4	16th day abscess cheek Temp. 99.4	20th day Dis. Erys. C.
38.	I.C.	53 fem.	2	Left cheek	3d day	Temp. but little above normal		5th day. Dis. C.

(e) Cases without recorded observation on 2d day which afterward had but one day of spreading

39.	M.H.	48 fem.	4	Unhealed abscesses head & neck	Rt. face & neck incl'g forehead	2d. no record 3d. Left face & ear	9th. P.M. normal (subsequent rise)	10th. Trsf'd Erys. contrid. 17th dis. w/out recur.
40.	C.C.	57 fem.	2		Face markedly swollen, incl'g forehead. Eyes partially closed	2d. No obsvn. 3d ?	9th. Drop normal w/out rise	11th day. Dis. C.
41.	L.F.	42 fem.	?	Larynx congested & mucoid secretion. Pyorrhoec Rheumatism.	Face markedly swollen. Eyes closed	Face covd. w. ichthyol & colloid. 2d. No record 3d ?	Temp. not reduced to normal (arthritis) but erys. well on 11th day	14th day. Dis. Erys. C.

(f) Cases having 2 days of spreading after admission

42.	J.A.	20 m.	7		Rt. face, neck & ear	2d & 3d	7th. Drop normal w/out rise	11th day. Dis. C.
43.	A.S.	39 fem.	4		Rt. face, cheek, Rt. forehead, both ears. Rt. eye closed	Oint. face. Tinc. scalp 3d forehead, 6th scalp	9th. Drop normal w/out rise	11th day. Dis. C.

TABLE I—(Continued)  
*Adult Facial and Scalp Erysipelas Treated with Chinolol Ointment and the Tincture Respectively.*

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of Spread	Estimated Duration	Sequels	Result
44.	S.F.	44 m.		3	Face	Ether & tinct. to scalp, oint. face	6th scalp 8th	11th. Drop normal w/out rise		13th day. Dis. C.
45.	F.W.	62 m.	Convalescent grippe	4	Rt. eye closed. Face, incl'g forehead	Face, oint. scalp tinct. sts. preceded w. ether	2d 3d evidently to scalp	7th. Drop ar. normal w/out rise		11th day. Dis. C.
46.	F.O.	71 m.		3	Lt. face incl'g ear, eyelids		3d 4th	6th. Drop normal w/out rise		7th day. Dis. C.
47.	G.D.	26 fem.	Alveolar abscess	3	Lt. face & ear. Much swelling. Eye closed		2d 3d	5th. Drop normal w/out rise		7th day. Dis. C.
(g) Cases having 3 days of spreading after admission										
48.	J.K.	38 fem.		?	Rt. face. Eye closed	4th back Oint. q. 2 hrs. day q. 4 hrs. nt. 5th back blotchy (above middle) Then controlled	3d back, 4th back, 5th back (blotchy)	5th. Drop normal w/out rise		12th day. Dis. C.

## TREATMENT OF ERYSIPELAS WITH CHINOSOL

49.	L.F.	37 m.	Post-op. mastoid	3	Neck & nearly entire face	4th upper back, ether & tinc. 6th back arrested & fading	2d 4th 5th } back	7th. Drop normal w/out rise	8th day. Dis. C.
50.	L.K.	27. m.		3	Nose, cheeks, lower lids, forehead		3d 5th 6th } to ear & scalp	7th. Drop normal w/out rise	11th day Dis. C.
51.	E.D.	20 fem.		5	Left face. Eye closed		3d 4th 9th slight	9th. Drop normal w/out rise	15th day. Dis. C.
52.	M.D.	37 fem.	Large fleshy	2	Cheeks, eyelids, forehead. Eyes partly closed		2d 3d 4th (no ointment)	6th. Drop normal w/out rise	7th day. Dis. C.
53	N.S.	40 m.		7	Left face eye almost closed Forehead & Rt. eyelids		2d (no oint) 3d 4th (scalp)	5th. Drop normal w/out rise	7th day. Dis. C.
54.	T.B.	45 m.	Eye chin. irritat. 4th & 8th 10th pol-yarthrits	5	Rt. side head incl g scalp, forehead, ear & face. Eye partially closed		2d (no oint.) 3d 4th	10th. Drop normal, 11th rise	11th day. transferred Med. Wd. Erys. C.
55.	Z.L.	54 m.	Post-op. mastoid Left	2	Left ear, neck, cheek & forehead	Scalp not treated in advance of spread	2d 4th 5th scalp	8th. Drop normal w/out rise	10th day. Dis. C.
56.	H.F.	52 m.		5	Entire face & Scalp tender	Scalp not treated until 4th day (Eth. & Tinc.)	3d 4th 5th scalp	6th. Drop normal w/out rise	7th day. Dis. C.

TABLE I—(Continued)  
*Adult Facial and Scalp Erysipelas Treated with Chinolol Ointment and the Tincture Respectively.*

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of spread	Estimated Duration	Sequels	Result
(h) Cases having more than 3 days of spreading after admission										
57.	C.W.	69 fem.		3	Almost entire face incl'g forehead, extending to neck. Eyes almost closed		2d ? 3d scalp 4th 5th neck 7th 8th	9th. Drop normal w/out rise		13th day. Dis. C.
58.	P.S.	33 m.	Drug habitué	5	Rt. face & neck, incl'g ear	9th ether preced'g tinc. to back begun. 11th erysip. back arrested (blotchy)	2d 3d 5th left face 6th back of neck 8th } back 9th } 10th }	11th. Drop normal w/out rise	Abscess of neck	13th day. Dis. Erys. C.
59.	P.B.	57 fem.		?	Face incl'g forehead	7th back (Ether & Tinc.) 9th back (upper % 10th back arrested & fading)	2d 7th back 9th back 13th sl.S. arm	10th. Drop normal highest subseq. rise 99.4. 12th day		18th day. Dis. C.
60.	J.M.	42 m.		4	Entire face markedly red swollen & tender	Spread scalp accomp'd treat. by unskilled hands. 7th Ether & T. abundantly to scalp, foll'd by arrest	3d 4th 5th } scalp 6th } 7th }	8th. Drop normal & thereabouts (99.8) w/out rise		10th day. Dis. C.

## TREATMENT OF ERYSIPELAS WITH CHINOSOL

See also  
Cases  
Nos. 62, 64,  
66

(i) Cases having recurrence during treatment

61.	A.S.	52 m.		4	Face & ears	9th recurrence during reg. treat. with oint. foll'g cold draft on face	2d no record 9th Recurrence left face Temp. 100°	10th drop to normal w/out rise	13th day. Dis. C.
62.	G.H.	52 m.	Steady drinker	3	Rt. side of face Rt. eye closed	Scalp, tinct. Face, oint.	2d no record 4th to foreh'd 5th to scalp 8th recur rt. face. 9th recurrence	11th drop to normal w/out rise	17th day. Dis. C.
63.	M.J.	35 fern.		5	Face & scalp marked swelling Eyes almost closed	First 4 days ointment to scalp, then tinct.	2d no record 6th recurrence both cheek & nose (had rubbed face)	7th. Drop to normal w/out rise	8th day. Dis. C.
64.	J.P.	36 m.		6	Rt. face & ear. Eye almost closed	Face, oint. Scalp, ether & tinct, 13th day	5th 6th 12th recurr. lower lids & adjoining cheeks (99.6°) (Had not rubbed face.) 13th 14th	10th temp. drop to normal for 3 days. Then rose again (102°), 15th temp. 100.8°	16th day. Dis. C.

TABLE I—(Continued)  
*Adult Facial and Scalp Erysipelas Treated with Chinosol Ointment and the Tincture Respectively.*

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of spread	Estimated Duration	Sequels	Result
<i>(k) Cases having recurrence following primary subsidence</i>										
65.	R.O.	39 m.	Cardiac valvular dis. Pulsating liver	5	Nose & cheeks (butterfly)		0	4th. Drop normal w/out rise		5th day. Transferred Med. W.d.
65.	Recur		8th rt. conjunctiva ac. swollen	2	After 10 days Recur. chiefly left face	Boric acid reduced conjunctival swelling before death	2d no record scalp 8th rt. upper lid (temp. normal)	5th. Drop normal w/out rise		9th day. Died
66.	V.S.	25 fem.	Marked kyphosis Post-op. mastoid	1	Around rt. eye which was closed	Spread to ear scalp & 1/2 way down back where controlled with ether & tinct.	2d 5th back 9th 11th back of head 14th 16th eyelid	15th. Drop normal without rise		18th day. Dis. C.
66.	Recur.				Swelling rt. eyelids 5 days after discharge			No elev. temp.		Rapid subsidence
<i>(l) Miscellaneous</i>										
67.	P.H.	39 m.		3	Face, both sides	Face oint. Scalp, ether & tinct.	2d } no record 3d } Evident spread scalp Otherwise 0	6th. Drop normal w/out rise		8th day. Dis. C.



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68.	L.L.	32 m.		3	Face, ears & scalp markedly swollen. Eyes almost closed	Face, oint. Scalp, ether & tinct.	2d } no record 3d } Otherwise 0	6th. Drop nor- mal w'out rise	8th day. Dis. C.
(m) Cases who died									
69.	S.M.	38 fem.		6	Both cheeks & forehead		2d no record Otherwise 0		5th day. Died
70.	J.G.	61 m.		3	Eyelids, cheeks, forehead		0		5th day. Died
71.	A.P.	46 fem.		Ab. 8	Face, scalp, upper neck. Eyes closed. Mar- ked swelling				2d day. Died

TABLE II  
*Adult Erysipelas of Extremities treated with the Tincture of Chinolol.*

No.	Name	Age & Sex	Complications	Day of Disease	Location on admission	Special treat.	Days of Spread	Estimated duration	Sequels	Result
1.	M.G.	50 fem.	Small ulcer rt. leg	7	Lower $\frac{1}{2}$ rt. leg. Entire leg swollen Lymphangitis. Ing. glands tender	Tincture	0	4th. Temp. drop normal w/out subseq. rise		8th day. Transferred Erys. C.
2.	S.Z.	55 fem.		5	Rt. leg (to below knee) & foot. Ing. glands tender	Tincture	0	7th. Drop normal w/out rise		11th day. Dis. C.
3.	E.F.	35 fem.		5	Entire rt. leg	Ether & tinct. Oint. added at beginning	0	9th. Drop normal w/out rise		14th day. Dis. C.
4.	A.R.	58 fem.	Varicose ulcer rt. leg	4	Entire lower part of right leg	Tincture	0	3d. Drop normal w/out rise		9th day. Dis. Erys. C.
5.	J.C.	45 m.	History of tuberculosis. Ulcer rt. leg	4	Rt. lower extremity, diffuse areas. Ing. glands tender	Ether & tinct.	2d Soreness continued until near end of stay	After 4th day temp. gen'ly not over 100°		14th day. Dis. C.
6.	C.C.	63 m.	Suppurating wound axilla. left	2	Left side chest & arm	3d, back, arrested. Tinct. chin. gen'ly preced. w. ether. At night sts. oint.	2d to back (blotchy). No further spread	Had but little rise of temp.	Increasing cedema incl'g hand, no pus, prob. thrombosis	11th day. Home

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7.	M.M.	35 fem.		I	Left leg (to be- low knee) Mar- ked swelling	Tincture chin. But little ether recorded used	6th	7th. Drop nor- mal with rise to 99.2°. 10th treat- ment stopped	8th blister heel	14th day Dis. Erys. C.
8.	W.R.	44 m.		4	Left leg	Ether & tinct. 3d. fol'g. gr. abundance of ether & tinct. swell- ing reduced 6th, few blisters oint. used applied by nurse	2d } little 3rd } spreadings 4th } localized 8th } extension of swelling. No further spread	6th. Drop with daily rise to around 100°.	12th } 16th } Small ab- scesses	

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TABLE III

*Facial Erysipelas in Children Treated with Chinosol Ointment.*

No.	Name	Age and Sex.	Day of Dis.	Location on Admission	Days of Spread	Estimated Duration	Result
1.	E. McG.	6 yrs. m.	3	Cheeks & chin	0	Temp. but little above normal	6th day. Dis. C.
2.	A. L'A.	10 yrs. m.	3	Rt. face, ear, forehead & scalp	0	But little elev. of temp.	6th day. Dis. C.
3.	F. Z.	1½ mos. m.	4	Rt. face	0	4th day temp. normal all day 5th day 100.4	6th day. Dis. C.
4.	E. F.	10 yrs. m.	3	Left face, incl'g. ear & foreh'd	0	7th day temp. normal all day	8th day. Dis. C.
5.	C. S.	15 yrs. fem.	3	Nose, cheeks, eyelids, forehead	0	6th A.M. drop normal without rise	7th day. Dis. C.
6.	J. C.	5 yrs. m.	3	Forehead	0	3d day drop normal without rise	4th day. Dis. C.
7.	T. K.	15 mos. m.	1	Face & neck spreading fr. submental wd.	2d } 3d } no observation 4th spread. Otherwise no spread	6th day drop normal practically without rise	8th day. Dis. C.
8.	J. S.	3 yrs. m.	2	Rt. face, ear and neck	3d to back 4th back 5th arms	7th day redness decreasing	10th day Dis. C.

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TABLE IV  
*Children Erysipelas of Trunk and Extremities Treated with the Chinosol Ointment.*

No.	Name	Age and Sex	Complications	Day of Disease	Location on Admission	Special Treatment	Days of Spread	Estimated Duration	Result
1.	R. W.	4 fem.	Infected finger		Whole rt. upper extrem. & shoulder		0	7th. Drop normal w/out rise	9th day. Dis. Erys. C.
2.	R. V.	3 fem.		3	Lower leg, left		2d to knee Lymphangitis inner thigh	5th. Drop normal with rise to 100°	7th day. Dis. C.
3.	S. M.	18 mos. fem.		Re-cent	Left leg from knee to ankle		No early observations made, but	3d. Drop normal w/out rise	8th day. Dis. C.
4.	G. J.	3 mos. fem.		3	Back	Erysipelas back checked	4th to arms 5th slight spread	7th. Drop normal practically w/out rise (99.4) 8th erys. well	9th day. Dis. C.
5.	W. H.	2 m.	Double otitis media purulenta. Wound of neck. Anæmic	3	Left forearm, arm, shoulder	Fr. abt. 7th to 12th days, oint. q. 2 hrs. day & q. 4 hrs. nt., sts. preceded by the tinct. but ether wash given only once per day. Oint. prac. over entire trunk & extremities. Fr. 12th to 14th tinct. used exclusively q. 4 hrs. togeth. w. some ether at sites of advance. 14th oint. exclusively	Fr. 5th to 14th daily spread trunk & extremities 14th isolated patch face 15th isolated patch face	Temp. ar'd. 104° until 10th day. Then genly 102° to 103°. Pulse good. 16th drop normal w/out rise 17th erys. well	24th day. Dis. C.
6.	L. P.	15 mos. fem.	Abcess neck, Enlarged cerv. glands. Anæmia	1	Back	Oint. 13th. Began applications q. 2 hrs. day & q. 4 hrs. night	2d to 5th (incl.) 7th to 10th (incl.) 12th to 18th (incl.) 20th Recurr. body 21st erys. faded	Temp. varied bet. 100° to 101° & 104° to 105° levels 20th 108.6°	22d day. Died
7.	A. S.	2 mos. m.	Malnutrition	7	Scalp, neck, face, chest, abdomen	Oint. q. 4 hrs.	Spreading unchecked	Temp. high	5th day. Died
8.	C. M.	5 wks. m.	Malnutrition	?	Diffuse about body				3d day. Died

*rences* following primary reduction of the inflammation, while still undergoing treatment in the ward. In Case 61 the lighting up of the subsiding inflammation was attributable to exposure to a cold draft, and in Case 63, to the trauma produced by the patient's having rubbed the ointment into her face, in both of which cases the temperature dropped to normal on the day following the appearance of the recurrence, without subsequent rise. In patients 62 and 64 there was no assignable reason for recurrence having occurred. Patient No. 64 had positively not rubbed his face. Case 6, Group IV, I. P., age fifteen months, spreading erysipelas of trunk and extremities complicated with cervical adenitis and anæmia, on the twentieth day of treatment, long after the erysipelas involving the trunk had cleared, though the extremities still harbored the disease, had a recurrence of the erysipelas to a considerable extent over the surface of the trunk somewhat irregularly. On the twenty-first day the erysipelas had everywhere faded and on the twenty-second day the patient died.

Of particular interest were the *cases of erysipelas which had more than three days of spreading*. (Group I, Class *h*, Cases 57 to 60 inclusive; Class *i*, Cases 62 and 64, and Class *k*, Case 66, and Group IV, Cases 5 and 6). In Case 58 it is noteworthy that the erysipelas of the back did not begin to control until ether was used on the skin surface preceding the application of the tincture of chinisol. In Case 60 erysipelas of the scalp, treated by unskilled hands, spread continuously for five days, but with the use of a correct technic, applying ether and the tincture of chinisol lavishly and extensively, it promptly became controlled. On the day following the institution of the proper technic in this case, all that remained of the soreness and swelling of the scalp, which had been extensive on the previous day, was limited to a small area over one ear.

In two children with erysipelas of the trunk and extremities (Group IV, Nos. 5 and 6), *the erysipelas spread for days unchecked by the treatment*, though the advance of the disease was slow. Case 5, W. H., a male child of two years of age, was complicated with anæmia and a double purulent otitis media with much discharge from the ears at the beginning of treatment. The ointment applied once in two hours in daytime and four hours at night was unavailing to stem the advance of the erysipelas. The use of the tincture of chinisol in conjunction with the ointment, without first washing off the grease from the skin with ether, as practiced on this patient, was not regarded to be a correct technic. Attending the exclusive use of ether and the tincture of chinisol once in four hours from the twelfth to the fourteenth days, the erysipelas of the trunk and extremities largely cleared and otherwise became checked, and then with the appearance of two isolated areas of erysipelas on the face, the disease, now treated with the chinisol ointment again, rapidly cleared entirely. The pulse continued good throughout.

Case 6, I. P., female, age fifteen months, thin, complicated with cervical adenitis and anæmia, was treated with the ointment exclusively, the same having been applied at first with routine frequency, but on and after the



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thirteenth day once in two hours by day and four hours by night. On the twentieth day the temperature rose to 108.6°, on the twenty-first day the erysipelas had entirely faded, the breathing was tranquil, the pulse regular and not excessively rapid, and on the twenty-second day the patient died. A final examination of the lungs shortly before death, failed to detect any evidence of pneumonia. In this case the erysipelatous areas affecting the lower extremities were at one time each limited to a narrow red stripe encircling each leg, which were observed to have advanced in their entirety, leaving normal-appearing skin in the areas just traversed. The advance of the disease was slow. With rubbing the ointment into the skin at the stated intervals, during a period of forty-eight hours, the amount of spread of the erysipelas was greater than it had been when the ointment was applied by simply smearing it over the skin surface.

Another case of erysipelas which could not be checked by the treatment, not in the series of cases herewith reported, but introduced in order to add an adult case of this nature, was one beginning in the face of a woman K. M., age thirty-five, admitted to the service on March 30, 1921, in whom at first a chinisol ointment was used which differed from the one used on the series of reported cases, in that its content of sodium chloride was but grs. iiss to the ounce. The erysipelas spread unchecked through the scalp and down onto the body. On the sixth day, when the erysipelas had spread three-fifths the way down the back, one special careful treatment was administered, first washing the skin freely with ether and then painting on layer after layer of the tincture of chinisol until about 2½ ounces of the latter had been taken up by the skin, but without avail. On the eighth day the same sort of ointment which had been used on the face was resorted to again for use on the body in place of the tincture. On the eleventh day the prior chinisol ointment, containing grs. iv of sodium chloride to the ounce, was substituted. After the twelfth day the ointment was applied to the skin surface of the entire body twice a day, while at the other three treatments it was applied only to the reddened areas and the skin in advance of the line of demarcation, the erysipelas now affecting only the extremities, the areas previously involved on the trunk and head having healed. On the eighteenth day the erysipelas affecting the upper extremities, which had reached the wrists, cleared. On the nineteenth day the erysipelas about the ankles, which was all that remained, had completely faded. On the twentieth day treatment was stopped, on the twenty-second day the temperature dropped to normal without subsequent rise, and on the twenty-fourth day the patient was discharged cured of her erysipelas. On the twentieth day a blood examination showed 11,000 leucocytes, 72 per cent. polymorphonuclears, 3,900,000 reds and 70 per cent. hæmoglobin. The temperature had fluctuated widely throughout the course of the disease, while the pulse, except for an occasional rise, had generally remained below 100 and had maintained a good volume. The patient was of a short slender type of physique. In this case, as well as in

Cases 5 and 6 of Group IV, in all of which the erysipelas spread for many days, the spread of the erysipelas was slow.

In Case No. 7 of Group IV, A. S., an infant, complicated with malnutrition, the spread was rapid and uncontrollable, and in this patient as well as in Case No. 8 of the same group, C. M., another infant likewise complicated with malnutrition, *exitus lethalis* quickly supervened.

*Erysipelas of the Back.*—Out of twelve cases in this series of erysipelas involving the back, the erysipelas of the back in eight cases—six adults (Group I, Nos. 48, 49, 58, 59 and Group II, No. 6) and two children (Group III, No. 8, and Group IV, No. 4)—soon became checked; in one case, a baby (Group IV, No. 5), it spread unchecked with ultimate recovery; and in three cases (Group IV, Nos. 6, 7 and 8), two of whom were malnourished infants and one was a puny baby, it spread unchecked with ultimate death. In Case 48, the erysipelas of the back was controlled while being treated with chinosol ointment, soon after increasing the applications of the latter to once in two hours in the daytime and once in four hours at night. The other five adult cases were treated with ether and the tincture of chinosol. In Case 58 the erysipelas was not controlled while the tincture of chinosol only was being used, but it was controlled shortly after beginning to wash the skin with ether, preceding painting with the tincture of chinosol.

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# VON RECKLINGHAUSEN'S DISEASE OR OSTEITIS FIBROSA

WITH REPORT OF A CASE PRESENTING MULTIPLE  
CYSTS AND GIANT-CELL TUMORS

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In the wards of the Philadelphia Hospital there is at the present time a young nigger, who presents a most monstrous appearance (Fig. 1). Immense solid bone tumors involve the upper and lower jaws; cystic tumors are present in the right and left humerus; pathological fractures with vicious fibrous union are noted in the right and left femur; there is extreme muscular atrophy; the spine and pelvis are greatly deformed; the X-rays show marked decalcification of the skeleton and osteitis fibrosa. This patient has been in the hospital for a year, during which time the affection has been stationary. She has been bedridden for over four years.

This is a case of Von Recklinghausen's disease, or osteitis fibrosa with multiple bone cysts and giant-cell sarcomata of the epulis type, a disease of bone exceedingly rare in this country, only four or five cases having been reported. As far as could be determined, it is the only case on record in which a member of the colored race has been affected by this peculiar malady.

There are a number of clinical and laboratory findings in this case which would tend to throw some light on the causes of this disease, namely: rickets, tumor of the hypophysis, and severe dental infection. The presence of these three conditions in this patient is manifestly suggestive that the disease could arise in the course of such a combination. The studies on animals by Edward Rehn, and by George Barrie, whose recent contributions upon bone pathology have been enlightening, tend to show endocrine disturbances, low-grade infectious processes, and errors in calcium metabolism in this disease.

S. J., colored, female aged twenty-one years, born in the United States, for the past four years has been bedridden because of fractures of the right and left femur. Within the past five years numerous bone tumors have appeared, involving the jaws and humeri.

Her family history is negative; mother dead, cause unknown; father living and well; no members of this family have had tuberculosis or cancer, nor was there any one affected with deformities of bones or joints.

Previous medical history: She was born at term; normal birth; artificial feeding; started to walk at two years of age. No illness during infancy or childhood. Was well until ten years of age, when she noticed slight knock knee. No treatment was instituted at this time. In 1912, her family moved to New Hampshire, where she lived a year. At this time the deformity of the knees became so bad that it interfered with walking. She attributed this condition to insuffi-

cient food, intense cold, confinement and lack of exercise. In 1913 was operated upon by Dr. A. C. Wood at the Howard Hospital, supracondyloid osteotomy of right and left femur. Was in the hospital six weeks, no apparatus worn after operation. On December 8, 1914, the right femur fractured after a slight fall and was treated at the Hahnemann Hospital. Buck's extension and coaptation splints. On February 17, 1915, it was found that fibrous union existed, the ends of the bones were free. A Lane plate was then applied. At this time the urine was normal, and the X-ray showed the fracture at the junction of the upper and middle third. Both fragments showed cystic degeneration. She was discharged May 13, 1915, apparently with good union.

In the fall of 1915, a molar tooth was extracted from the left lower jaw. Shortly after this a tumor developed in the socket which grew very rapidly, and soon caused a marked expansion of the alveolar process. About three or four weeks after this, pain and stiffness developed in the left shoulder and elbow joints. The upper and lower ends of the humerus began to expand and in the course of six months they were so large as to interfere with the function of the shoulder and elbow. (Fig. 2.) At no time did she have much pain while these tumors were growing. In the early part of 1917, the upper end of the right humerus began to expand, reaching its present size within six months. This tumor has not grown larger since. On February 19, 1918, while standing at the side of a table the left femur fractured spontaneously in its middle. (Fig. 3.) At the Hahnemann Hospital, where she was treated, the records showed the following conditions: old fracture of the right thigh with vicious fibrous union, scoliosis, contraction of the pelvis, swelling of the lower third of left femur and upper third of right femur, expansion of left lower maxilla, extreme muscular atrophy. Röntgenographic examination of the bones involved, showed swelling and deformity, decalcification and replacement of lime salts by fibrous tissue. The opinion expressed by the röntgenologist at this time was osteitis fibrosa of the general type. The Wassermann test was negative, the urine contained albumen and some pus-cells. Blood showed the following: 5600 leucocytes, 3,146,000 erythrocytes, 70 per cent. hæmoglobin, differential count, polymorphonuclears 51 per cent., small lymphocytes 41 per cent., large lymphocytes 6 per cent., transitionals 2 per cent. A section was removed from the left lower jaw for pathological examination, and the report was osteo-sarcoma of the giant-cell variety.

About two years ago the left superior maxillary bone was involved, the tumor which apparently expanded the antrum, grew very rapidly toward the left nasal chamber almost occluding it.

Eighteen months ago the right inferior maxillary bone began to expand and within a period of three months the tumor reached its present size. At no time did she have pain during the growth of these tumors. About a year ago she had frequent and profuse hemorrhages from the mouth. The bleeding came from the swollen gums and ulcers of the hard palate. At present she does not bleed. She has been in bed for four years; rarely complains unless the fractured limbs are disturbed. Appetite is poor, mastication is impaired, has headaches occasionally, and is constipated. She has never menstruated and growth has been arrested since 1912.

*Physical Examination.*—General: When one views this patient for the first time, he is impressed with the marked deformity of face and upper extremities. The patient lies in bed unable to move without pain. There is a marked degree of muscular wasting. She has a fairly intelligent look, her speech is distinctly nasal in quality, her disposition seems to be docile.

Head: The head is very large and square, and its size is out of all proportion to her body, which is quite small. There are no bony lumps on the skull. The

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circumference is thirty-two inches, the length of the face from the symphysis menti to the hairy margin of the forehead is eleven inches. The face is distorted by massive bony tumors of the right and left inferior maxillary bones and by an osteocartilagenous tumor filling the left nasal space and expanding its walls. There is a marked deflection of the septum to the right. Respiration through the nose is possible, but only through the right nostril.

Ears: The ears appear normal. Hearing, however, is markedly diminished on the right side because of the occlusion of the external auditory meatus by the tumor of the right inferior maxilla.

Eyes: The eyes react to light and accommodation. The pupils are equal in size, conjunctiva is negative.

Mouth: The buccal cavity is markedly contracted by the bulging tumors which involve the jaws. The alveolar process of the lower jaw is greatly thickened. It is broad, and the space between the cheek and jaw is practically obliterated. It appears confluent with the cheek. The right inferior maxilla is massive in appearance. It is rough, hard and in certain places nodular; painless to touch. It reaches from the symphysis menti to the temporo-mandibular joint to the malar bone and obliterates the submaxillary space. The inferior maxilla of the left side is also enlarged but not to the same extent as the right one. The hard palate presents a central furrow on each side of which are two convex bulging surfaces. There is an extensive ulcer involving the entire right half of the hard palate. This ulcer bleeds very freely at times. There is a pathologic fracture at about the middle of the horizontal ramus of the right inferior maxilla. Crepitus can be easily elicited. The teeth in the upper and lower jaw are rather small, irregular in size and shape, in places, are covered over by the hypertrophic gingival mucosa. This is bluish red in color, very spongy and bleeds freely when irrigated. There is a soft spongy mass violaceous in color, about the size of a hazel nut, situated posteriorly to the lower incisors, which also bleeds freely at times. This apparently is an epulis. There are numerous ulcerated areas on the gums, a number of teeth show decay and there is marked pyorrhœa alveolaris.

The tongue is negative. An examination of the throat was difficult because of the contracted condition of the mouth. However, nothing was seen either in the pharynx or the tonsils indicating any abnormality. Deglutition is normal.

Neck: The neck is negative.

Thorax: The thorax is small and narrow and shows a marked degree of emaciation. The supra-and infra-clavicular fossæ are depressed. The clavicles show exaggerated curvatures. At the costochondral junction, there is evidence of considerable thickening, producing a characteristic rhachitic rosary. The lower costal margins flare out, showing a distinct groove on either side. The intercostal spaces stand out very distinctly as parallel depressed rows. The sternum is prominent, giving the chest the appearance of being pigeon breasted.

Lungs: Respiratory movements are shallow. Both lungs move equally and there appears to be no lagging at either apex. Percussion, negative. Auscultation reveals fine râles at the left apex which is suggestive of pulmonary tuberculosis.

Heart: The heart is negative. The apex beat is in its normal position. No murmurs audible.

Abdomen: The abdomen is large and distended. The liver is felt two finger breadths below the right costal margin. The spleen is not palpable. The lower pole of the left kidney is felt opposite the crest of the ilium. There is some tenderness over the region of the bladder.

Spine: It is difficult to examine the spine because the patient cannot be made to sit up. With the patient lying on her side, there is noted a kyphosis in the



upper dorsal region. There is also a slight lumbar scoliosis to the right. The spinal muscles are atrophic.

**Pelvis:** The pelvis is distorted and greatly contracted. The distance between the anterior superior spines is 23 cm. and the anterior posterior diameter is 15 cm. There is some tilting of the right ilium upward.

**Extremities:** The left humerus is hour-glass in shape with two bulbous expansions appearing at either end of the bone. The upper end of the left humerus is rough and irregular. It is somewhat fusiform in shape. The expansion of this end of the humerus interferes with the movement of the shoulder-joint and abduction is limited to about ninety degrees. The tumor is painless. The lower end of the humerus is globular in shape and the tumor encroaches into the elbow-joint. The elbow cannot be extended beyond a right angle.

The tumor is eleven inches in circumference. It is hard and rough on the outer surface but it crepitates on pressure on the inner surface. The growth of the left arm apparently has been arrested. It measures eighteen and a half cm. while the forearm is twenty-three and a half cm.

The upper end of the right humerus presents an irregular, hard, nodular tumor, which encroaches into the shoulder-joint. There is some outward bowing of this bone. The right humerus measures sixteen and a half cm. and the right forearm twenty-three and a half cm. There is also some limitation of movement on abduction of the right arm.

The radius and ulna appear to be normal in size and shape, no bony tumors being in evidence. A striking deformity is noted in the terminal phalanges of all fingers. There is a dorsal curvature of all these bones. When the fingers are extended, these phalanges are almost at right angles to the fingers. The nails partake in this curvature and they curl backward. They are claw-like in appearance. (Fig. 4.)

**Lower extremities:** Both thighs are deformed. About the middle of the left thigh, there is an acute angulation with the apex of the angle inward. The leg is everted. The left thigh is swollen and painful when motion is attempted. There is an extensive infiltration about the middle of the left femur. Flexion and extension of the left knee is possible but limited, owing to the pain that is induced at the site of the old fracture. Motion at the left hip could not be elicited. The right femur is dislocated upwards and backwards. In the region of the great trochanter, there can be observed a rectangular projection about two inches long and one-half inch wide, which lies obliquely upon the upper and external aspect of the thigh. This apparently is the plate that was inserted several years ago, the ends of which appear very superficial, almost underneath the skin. There is some motion at the site of this fracture.

Both knee-joints appear enlarged, a slight degree of motion is present, adhesions within the joints, and fibrotic hypertrophy of the surrounding soft structures prevent a normal range of motion. Both legs and feet present no deformities. On the anterior surface of the left tibia a number of elevated areas are noted. These are soft tender swellings, non-inflammatory, probably subperiosteal hemorrhages. The bones of the legs are normal in length.

Genitalia and nervous system are negative.

**Laboratory examinations.**—Urine, specific gravity 1010, color white, albumen trace, no sugar, no Bence-Jones bodies, leucocytes, no casts.

**Blood.**—Hæmoglobin 55 per cent., leucocytes 10700, erythrocytes 1,370,000 polymorphonuclears 55 per cent., small lymphocytes 40 per cent., transitionals 40 per cent., basophiles 40 per cent.



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## Quantative Analysis of the Two Samples of Urine:—

	7-15-21		7-22-21
Volume .....	1630	cc.	1200
Sp. gr. ....	15		18
Solids .....	64	g.	56
Reaction .....	70	cc.	neutral
	N/10	NaOH	
Tot. N. ....	3.95	g.	3.84
NH N .....		g.	1.09
Creatinin .....	231	mg.	240
Creatin .....		mg.	240
Uric acid .....		mg.	325
NaCl .....	6.3	g.	4.8
P .....	.49	g.	.51
CaO .....	.206	g.	.188
MgO .....	.098	g.	.083
S .....	.256	g.	.265

## Chemical Examination of the Blood:—

Urea N. ....	10	mg.	per	100	c.c.b.
Creatinin U. ....	102	mg.	per	100	c.c.b.
Uric acid .....	4.6	mg.	per	100	c.c.b.
Sugar .....	109	mg.	per	100	c.c.b.
Chloride .....	660	mg.	per	100	c.c.b.
Nonprotein N.; .....	25				

Radiographic Examination by Dr. E. Burvill-Holmes, Röntgenologist of Philadelphia Hospital.

Left Elbow: There is considerable enlargement of the bone with marked thinning of the compact tissue and the presence of trabeculae. No definite cystic formation can be demonstrated.

Femur: The left femur shows a pathological fracture at the middle and upper third, with formation of false joint. The latter is also noted in the soft tissues by a definite fold over the site of fracture. The compact tissue is here thinned also, although the bone shows no enlargement. In fact, the bone is under-developed. Few trabeculae are demonstrable about the head of the bone but none in the shaft. There is a definite mottling of the cancellous tissue. The hip is dislocated. The right femur is similar to the left, a fracture being present about the neck of the bone. A plating operation has been performed, the plate still being in the situ. No callous formation. The head and neck are rarefied and the head is dislocated downward.

Hands: A peculiar claw-like distal phalanx is seen. There is enlargement of the second phalanx of the index finger with thinning of the compact tissue. A suggestion of a similar condition exists in the second phalanx of the adjoining finger.

Skull: Bone detail is lost in both maxillae. These bones are swollen and have a roughened putty-like appearance. The teeth have no real bony support and there are many apical abscesses. Delay is also evident in the eruption of the third molars. A pathological fracture is demonstrable on both the left and right mandibles at the neck of the bone and a definite cystic condition exists. The outer plate of the skull is roughened and markedly thickened and has a blurred appearance, similar, but of course to a much lesser extent, to that seen in cases

of osteitis deformans. The sella turcica is elongated, the floor is thin and the posterior clinoid process is pushed upward, suggestive of hypophyseal tumor.

Diagnosis: Osteitis fibrosa. We are of the opinion, however, that a second pathological condition is existent in the maxilla-new growth, the nature of which is indefinite.

Osteitis fibrosa is an interesting disease of bone, first described in 1891 by Von Recklinghausen. He differentiated this disease from osteomalacia by demonstrating the presence of calcium absorption and fibrous metaplasia. He showed that the pathologic changes within the bone and marrow were the results of chronic inflammation. The formation of fibrous tissue, bone cysts, and giant-cell tumors, within the bone are various phases of this affection.

Two types of this disease are recognized, a local and a general form, the former being far more frequent in occurrence. Bloodgood, in 1910, collected sixty-nine cases, twelve of which he considered general osteitis fibrosa. Silver, in 1912, collected ninety-seven cases from various sources, seventeen of which were of the general type. Elmslie, in a comprehensive monogram on this disease, fails to mention any personal experience with the general form, but reports six cases abstracted from foreign literature. Cases of the generalized form of osteitis fibrosa have been reported by Percy, Hausling and Martland, DaCosta, Funk, Bergheim and Hawk, Crile and Hill, Willard and Andrus, and Barrie. Case reports of this disease in the foreign literature are quite numerous, only two of which will be briefly abstracted because they are so strikingly similar to our case. Rehn reported a case in a young woman aged twenty-four years, whose disease began with an epulis of the lower jaw, when she was eleven years old. Ten years later, when again observed, she had a large giant-cell sarcoma of the upper jaw with characteristic changes of osteitis fibrosa and cysts throughout numerous bones of her body. Von Haberer recorded a case in a boy thirteen years old, who first presented a tumor of the lower jaw in the third year, spontaneous fracture of the right femur in the fifth and eighth year, both uniting. There was a cystic expansion of the upper part of the shaft of the right humerus and the middle of the shaft of the right tibia.

*Etiology.*—Numerous theories have been advanced by different observers as to the cause or causes of this obscure affection. Virchow thought that the cystic degeneration was due to absorption of enchondromata. Boit believes that the changes in the bones result from toxic metabolic or infectious processes and derangement of internal secretions. In an interesting comparative study, he shows that leontiasis ossea and osteitis fibrosa are identical histologically. Lubarsh and Rapke believe that the disease is an infectious one and they have found organisms in the contents of the cysts. Von Mikulicz stated that osteitis fibrosa results from a perverted growth of bone and marrow, the balance between bone formation and absorption being disturbed, the osteoclasts taking on excessive function and the connective-tissue elements in the marrow developing to an extreme degree. Rehn has shown that the changes in the facial and nasal bones in animals suffering from



FIG. 1.—Osteitis fibrosa with giant-celled sarcomata.

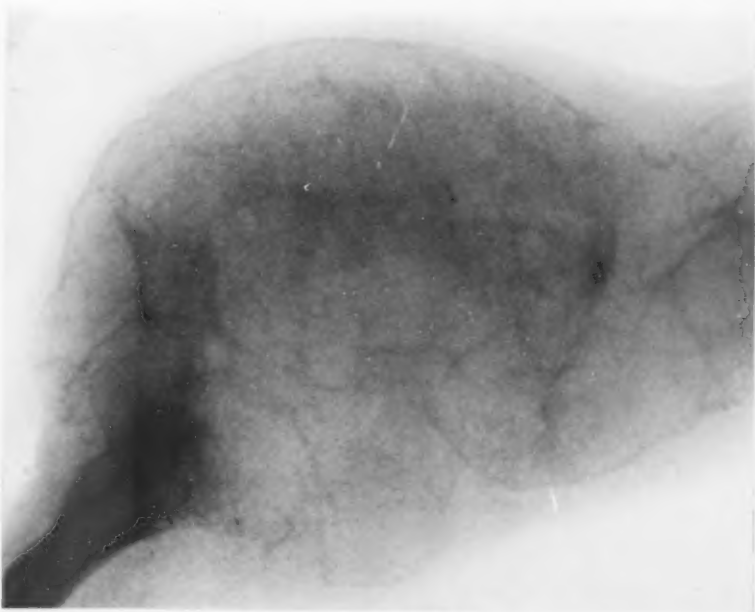


FIG. 2a.—Osteitis fibrosa showing sarcomata of humerus.

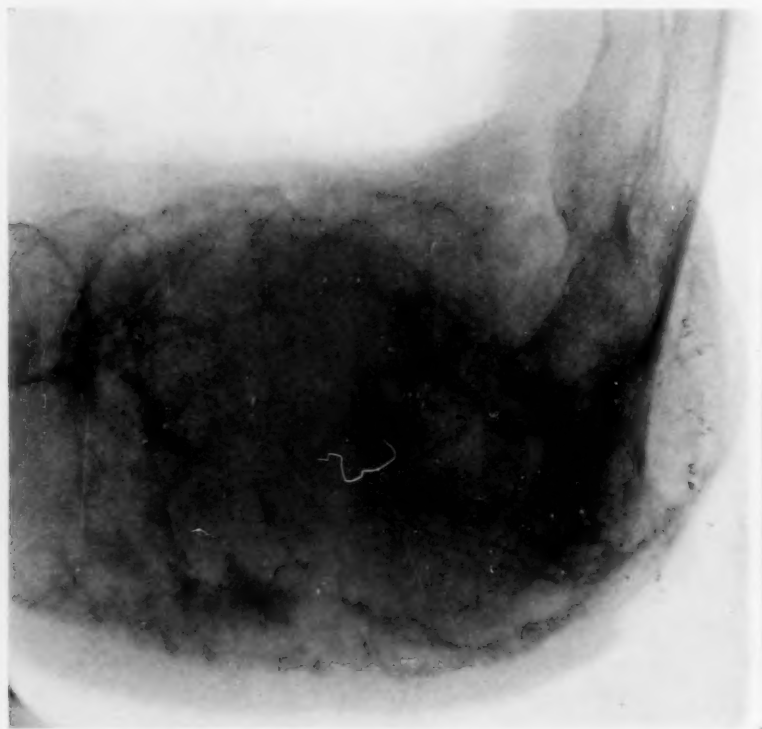


FIG. 2b.—Osteitis fibrosa showing sarcomata of humerus.

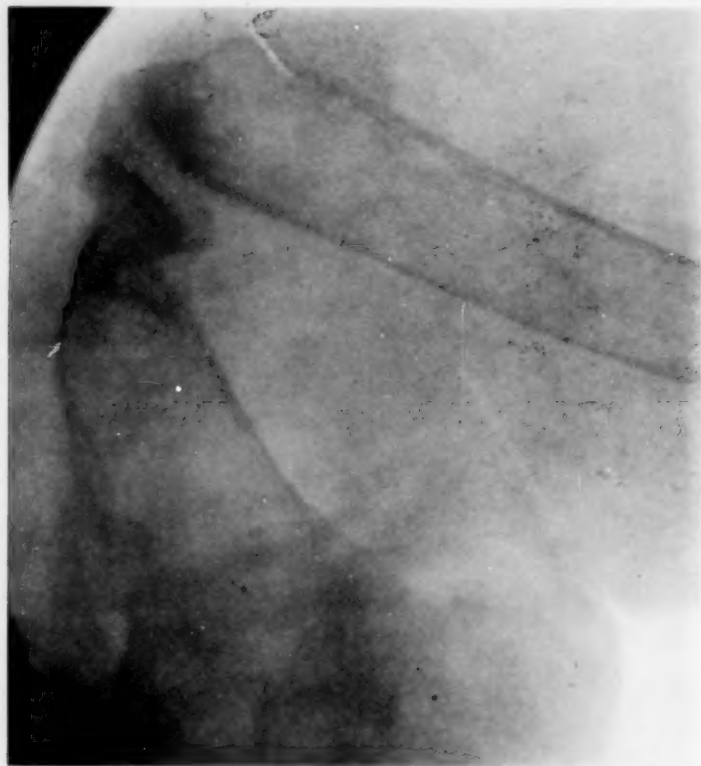


FIG. 3.—Osteitis fibrosa showing spontaneous fracture of femur.



FIG. 4.—Osteitis fibrosa showing phalangeal changes.





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osteitis fibrosa are much the same as those observed in man. In swine he has observed that the changes are apparently caused by an inflammatory process starting about the teeth. This observation seems to correspond rather closely with the findings in our case.

The nature of this type of bone disease is intimately bound up with some grave nutritional disturbance, in which calcification of one bone is retarded. A severe form of rickets may be considered a predisposing cause of this affection. McCrudden states that in severe rickets not only may the blood fail to supply lime salts to parts of the bone which should calcify, but the bone may be destroyed which has already been calcified and lay down osteoid tissue instead, and in this sense it may resemble osteomalacia. Inflammation of the immature bone and marrow can be followed by fibrous metaplasia.

Not all cases of rickets develop osteitis fibrosa, but if there be some additional factors, such as infectious processes and endocrinal disturbances, it is likely that osteitis fibrosa may develop. The chronicity of the affection indicates that the product of these infectious agents are of low toxicity, tuberculosis, syphilis or pyogenic diseases of low type, for instance.

Barrie has shown in a recent contribution the relationship which exists between these various causative elements and the production of hemorrhagic osteomyelitis. In a comparative study of osteitis fibrosa and hemorrhagic osteomyelitis and fibrocystic osteomyelitis, there appears to be a close identity between them etiologically and histologically.

Traumatism does not cause the general form of this disease, although there is distinct evidence to show that local osteitis fibrosa and benign bone cysts are caused by trauma.

*Pathology.*—There is defective calcification of the bones, which leads to thickening, weakening and deformity of one or many bones of the limbs, jaws, skull or trunk. The process is a general one, in which bone is replaced by cellular fibrous tissue, which may either start in the marrow, replacing it, or the fibrotic metaplasia may begin in the cancellous substance of the bone and later invade the medullary cavity. The formation of bone cysts is produced by a liquefaction of the fibrous tissue, or giant-cell sarcomata, usually of the epulis type, may develop in these areas of metaplasia. The bone is distended and partitioned off by trabeculae, the contents consisting for the most part of fibrous connective tissue. In the walls of the cysts may be found giant cells in great numbers.

The presence of these cells and their significance in this disease has caused considerable controversy in the past. According to Ewing, Hektoen, Mallory and Barrie, these cells are not malignant. They may be found in bone which is undergoing a reparative process. They are very large cells and contain many nuclei; they are closely allied to the giant epithelioid cells found in inflammatory regions, and their function is to act as scavengers, carrying away detritus.

Some consider these cells large osteoclasts whose normal habitat is in

Howship's lacunæ and whose presence in large numbers in the walls of these bone tumors is called forth by some unknown irritant.

The long pipe bones, such as the femur, humerus, tibia, are most frequently affected. The disease starting at the extremities of these bones extends upward affecting the shaft, and distending it. The expansion as a rule is oval and sometimes globular. Rarely is the cortex broken through. The epiphysial cartilage may be invaded, causing an arrest in the growth of bone. In one case the epiphysial cartilages of both humeri were destroyed, producing a marked shortening of these bones. The joints are rarely invaded, although the proximity of the expanded tumors near the ends of the bones interferes considerably with their function.

The contents of these cysts may be serous if the disease has existed for a long time. In an earlier stage of the process the content simulates currant jelly; sometimes it is gelatinous and chocolate brown. The tissue within the excavated bone may resemble exuberant granulations. Sometimes hemorrhage from these tumors is very profuse, when an opening is made in them. There may be a thick lining membrane of fibrous connective tissue around the cyst and in other instances there is no membrane. The periosteum is not thickened and the bone is uniformly rarefied and shows the characteristic trabeculation. The end results of this generalized condition is fibrosis of bone. As in tuberculosis of bone the striking feature is the formation of fibrous connective tissue in which the regeneration of bone takes place, only to a very limited extent, if at all.

*Symptoms.*—The clinical course of this affection begins insidiously in the young child or adolescent. The child may complain of vague rheumatic pain in the extremities. The patients may consult their physician for some secondary manifestation of this disease, such as knock-knee or bow-legs or pes valgus. Usually until some accident calls attention to the condition, it is apt to be overlooked. Fractures of the bones are very common and they usually result from some trivial injury or are spontaneous. Bones unite very slowly, and sometimes fibrous union results. Quite early in the disease, tumors appear at the ends of the long bones and the bones of the face. These tumors make their appearance suddenly, grow rapidly for a while, and then their progress is arrested. Owing to the softening of bone, deformities of spine and pelvis are quite marked. During the course of the disease pain is not a leading symptom. There is considerable muscular atrophy, and these patients are very often bedridden for months and years. Hemorrhages may occur from the mouth and nose. Dental caries and pyorrhœa alveolaris of severe types may be present. The presence of these tumors in the bones of the maxilla interferes with mastication.

The X-ray findings are quite characteristic and are distinctly diagnostic of the affection. The bone is expanded and the affected area is extensively subdivided by trabeculæ, the cortex is thinned, well marked and regular. There is no sclerosis of the surrounding bone nor thickening of the periosteum. The expansion is egg-shaped, and it gives one the impression of

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having started from the middle and spread equally in all directions. The appearance of those tumors which represent an earlier stage of the disease cannot be made out definitely by the X-ray. There is expansion of bone but trabeculation is not present. Fine bone detail cannot be made out, the bone has the appearance of putty with here and there a light space, which may indicate normal bone. The blood findings in these cases show a marked reduction in the hæmoglobin and red cells. The red-cell count may be as low as a million or less, because of the destruction of the bone-marrow. There is usually increase in the magnesium and calcium content of the plasma, indicating that the bones are unable to utilize these mineral salts.

The urine may contain albumen and casts. Bence-Jones bodies are not found. Quantitatively there is an increase in output of phosphorus and calcium, and creatin. The course of this disease is from eighteen months to eighteen years, and death usually occurs from cachexia or intercurrent disease.

The diagnosis is based upon the following: Occurrence of multiple spontaneous fractures, which rarely unite normally, associated with tumors, which involve numerous bones of the body, by the slow progress of the disease, beginning in childhood or early adolescence, and by the characteristic X-ray findings. These cases are often mistaken for sarcomata or osteochondromata. A pathologic examination of a specimen will then show the characteristic fibrotic change in the bone and the peculiar giant-cell content.

The prognosis in a case of this character is uniformly bad. Nothing in the way of a cure is known. Our patient has had the benefit of a course of radium and X-ray without any effect upon the course of the disease. She has been treated internally with phosphorus, calcium, arsenic, pituitary and thymus gland extracts without any apparent benefit to her. Surgical treatment can be applied in the treatment of the fractures and to the bone cysts if they be accessible. But these measures result in failure quite often. However, in the local form of the disease, curettage and implantation of a bone graft promptly cure the condition.

### CONCLUSIONS

1. Osteitis fibrosa, under which may be included benign bone cysts, giant-cell sarcoma of the epulis type, hemorrhagic osteomyelitis and the generalized form (Von Recklinghausen's disease) is a distinct pathologic entity characterized by a fibrous metaplasia of bone.

2. Two types of the disease are recognized: a local and a general type. Local osteitis fibrosa and benign bone cysts are dependent upon trauma in a great majority of instances. The general form is dependent upon grave nutritional disturbances. Endocrinal glandular dysfunction, faulty calcium metabolism and chronic infection of a low grade seem to be of etiologic significance.

3. Cysts, osteitis fibrosa cystica and giant cells may occur in the same bone. The giant-cell content is not prognostic of malignancy.

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4. Diagnosis of osteitis fibrosa is based upon the long duration of this process with very vague symptomatology, the frequency of spontaneous fractures and upon X-ray examination. Very often microscopic examination of pathologic sections is necessary to clear up the diagnosis.

5. The local form of the disease is benefited by curettage and bone transplant. The type showing multiple lesions must be given constitutional treatment directed toward the underlying constitutional disturbance. If the lesions be accessible, curettage and bone transplant may be employed. The X-ray and radium have been used in these cases with some success.

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## NEURO-FIBRO-MYXOMA TREATED BY CONSERVATIVE OPERATION

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AND

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FROM THE SURGICAL CLINIC OF THE ROBERT W. LONG HOSPITAL

CASE reports of single tumors of the larger nerves are so few that our knowledge of the clinical behavior of these growths after operation is rather scanty. The surgeon at the time of the operation seems often to have been in doubt in regard to the benign or malignant character of the tumor. He therefore has not known exactly how radical a removal of the growth is required. It seems to us after careful study of the microscopic structure of the two tumors considered in this paper, that even this method may fail to be conclusive, since we encountered many fields (see Figs. 3 and 5) which are decidedly sarcomatous in appearance. Yet the clinical results show that both tumors were benign.

CASE I.—Mr. H. D., age forty-two, white, was admitted to the Robert W. Long Hospital, December 30, 1915, with the complaint of a "tender knot" above and behind the collar-bone.

Family History: Father died of carcinoma and diabetes. Five other blood relatives died of diabetes. Otherwise negative.

Past Personal History: General health always good. No serious illness except frequent "colds." He had had no surgical operations except incision of an upper cervical lymph-node which had suppurated. This was found not to have any connection with the present condition.

General History: Gonorrhœa at age of nineteen without complications and sequelæ. Married ten years; wife never pregnant. Wassermann negative.

Present Condition: Upper cervical lymph-node removed twelve years ago. One year later a small tumor was noticed behind and above the collar-bone on the left side. This was painful only on examination. Later his collar irritated the tumor by its constant pressure, giving a sensation not unlike that produced by pressure on the "crazy bone." The lump was about as large as a small hazelnut. There was a gradual increase in size until last year when it reached the size of an English walnut. It has doubled in size during the past year and is now about the size of a hen's egg. Since the rapid increase in size, besides the sensation imparted by the tumor mass, there has been almost continuous pain in the shoulder region.

Examination showed a man apparently in good health and well nourished. There was a tumor in the cervical region situated about 1 cm. anterior to the anterior border of the left trapezius and just above and behind the clavicle. The tumor was oblong and about 2 cm. in diameter; was smooth and not attached to the skin and moved fairly freely



over the underlying structures. There was no pulsation. It was crossed transversely from below and behind, upward and inward by a cord-like structure, probably the omohyoid. There was no motor disturbance of the arm or shoulder and no sensory disturbance except the pain before mentioned in the shoulder region; no generalized lymphadenitis.

The heart and lungs were negative except for a slight systolic murmur at the apex which was not transmitted. Urinalysis negative, except for a very faint trace of albumin. Leucocyte count, 7000; hæmoglobin, 90 per cent. Diagnosis: Benign tumor of the nerve sheath.

Operation by Dr. W. D. Gatch, December 31, 1915. The operation was started with local anæsthesia, but the tumor was so painful and adherent to the outer cord of the brachial plexus that general anæsthesia was resorted to. Two large nerve trunks were dissected from the tumor mass. The surrounding tissues were freed and the tumor peeled out. A frozen section was immediately made, which appeared somewhat sarcomatous in character, but it was deemed advisable to do nothing more radical. One small rubber drain was inserted and the skin closed with plain silk. The patient made an uneventful recovery and was discharged January 4, 1916, the wound having healed by primary intention.

The gross specimen lab. No. 710 has an oblong shape. After being preserved in formalin, it measures 5 cm. long by 3 cm. wide and  $1\frac{1}{2}$  cm. thick. It is oblong in shape and somewhat flat. The specimen at one pole is rather firm, at the other soft and of a grayish-white color. On cutting no little resistance is offered. On holding a specimen up to the light and looking through a thin section there is seen to be a dense area between which are areas of thin transparent-like tissue. The tumor has on one side a smooth contour. On the side proximal to the nerve trunk is a somewhat ragged surface where it was adherent to the nerve sheaths.

Microscopic Section: The tissue is essentially fibrous and myxomatous in character, chiefly the former. The fibrous tissue is for the most part very dense (see Fig. 1). Here the cells are comparatively few in number and the connective-tissue bands very wavy and crowded together. The blood-vessel walls in such an area are very thick and dense and take a homogeneous eosin stain and appear to be hyaline in character. There is practically no nuclear material in these vessel walls, and the walls are without elastic tissue. The vessels do not have the appearance of being congested.

Such an area in places blends into another area which has a distinct myxomatous character (see Fig. 2). Here the tissue substance tends to have a more homogeneous appearance and contains but few fibrous tissue bands. The cells are somewhat stellate or elongated. In places there are a good many blood-cells scattered about the fibrous bands. The blood-vessels in such an area contain more blood. This has the appearance of a small hemorrhagic area.

There are small areas in the vicinity of a blood-vessel in which the tissue seems more cellular with rather thin-walled blood-vessels and



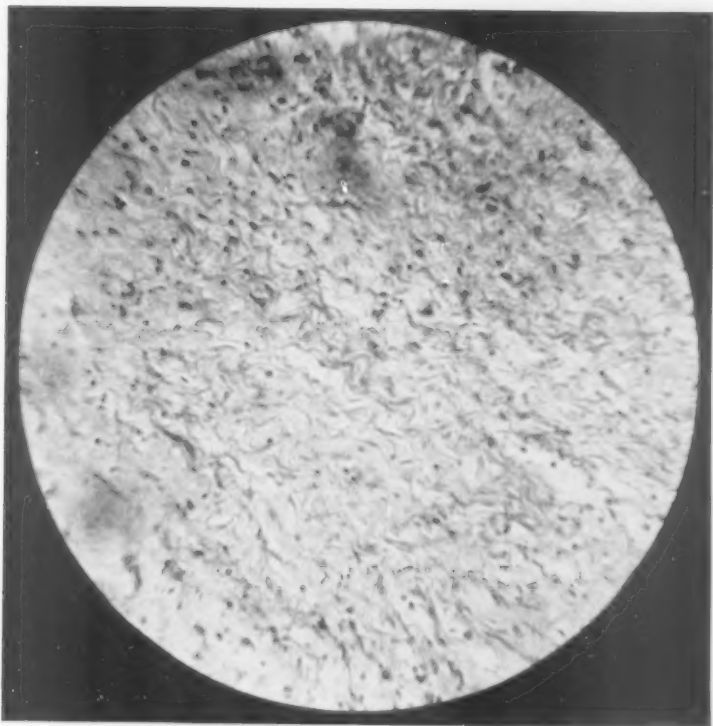


FIG. 1.—Photomicrograph. Showing a dense fibrous area. Note the wavy fibrous tissue.

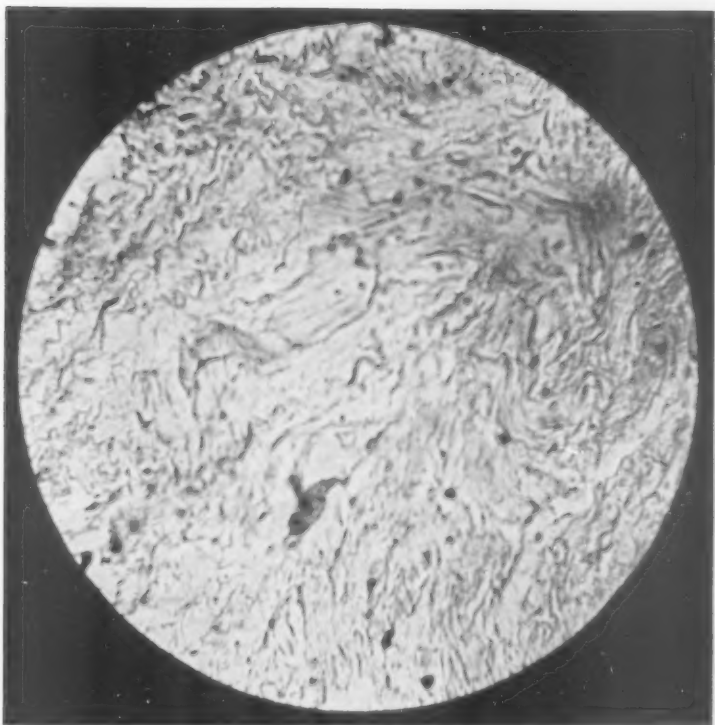


FIG. 2.—Photomicrograph of Case I showing area of myxomatous tissue.

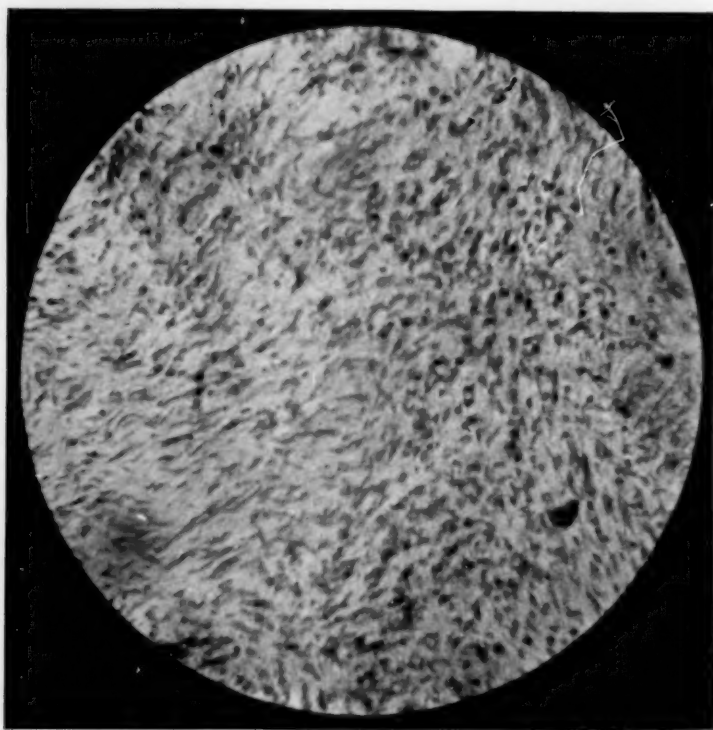


FIG. 3.—Photomicrograph Case I. Showing the very cellular area very much resembling sarcoma.

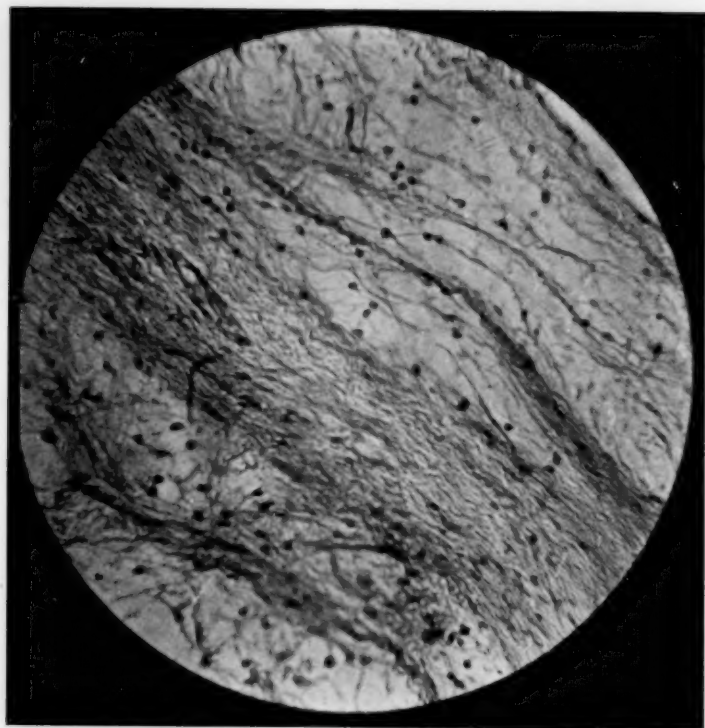


FIG. 4.—Photomicrograph of tissue Case II. Note band of dense fibrous tissue. Note also stellate nuclei or myxomatous tissue on either side.

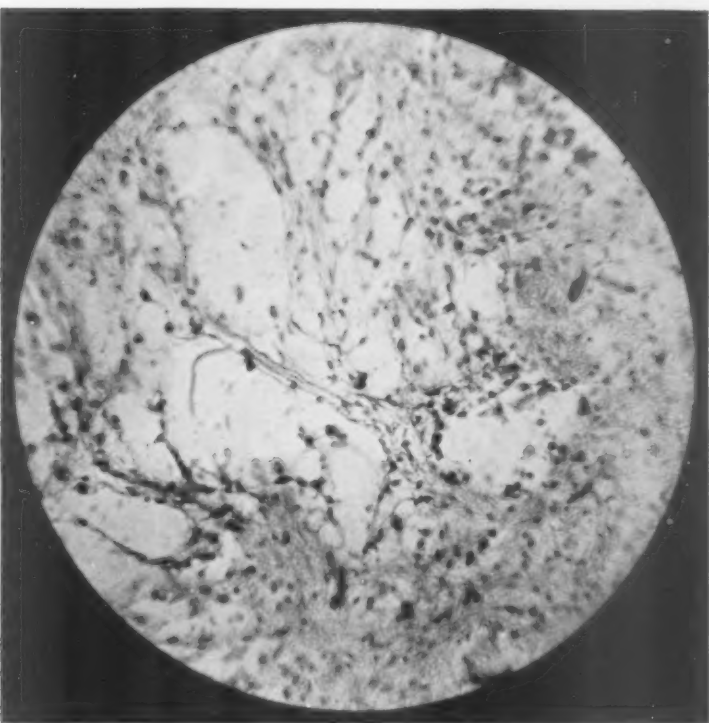


FIG. 5.—Photomicrograph of Case II, showing areas of myxomatous tissue. Note tendency to cellular areas and absence of fibrous tissue.

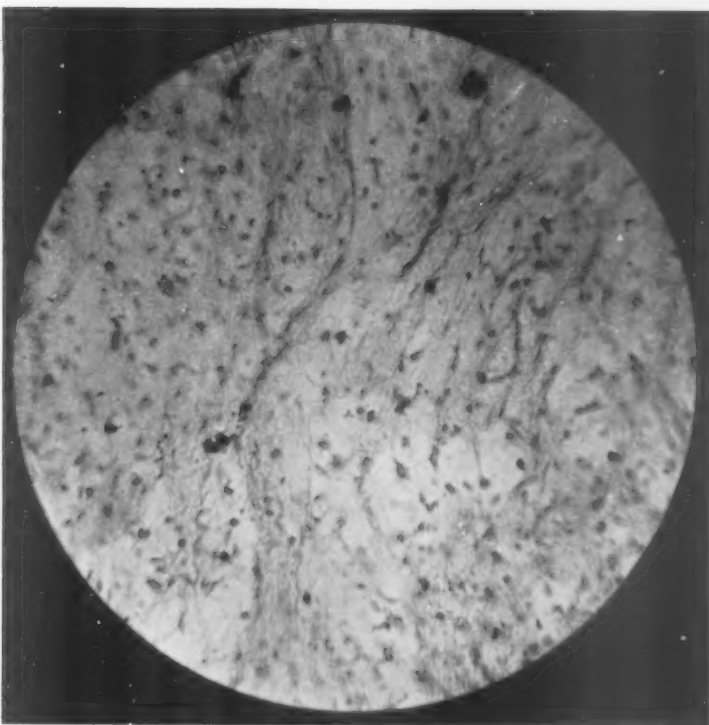
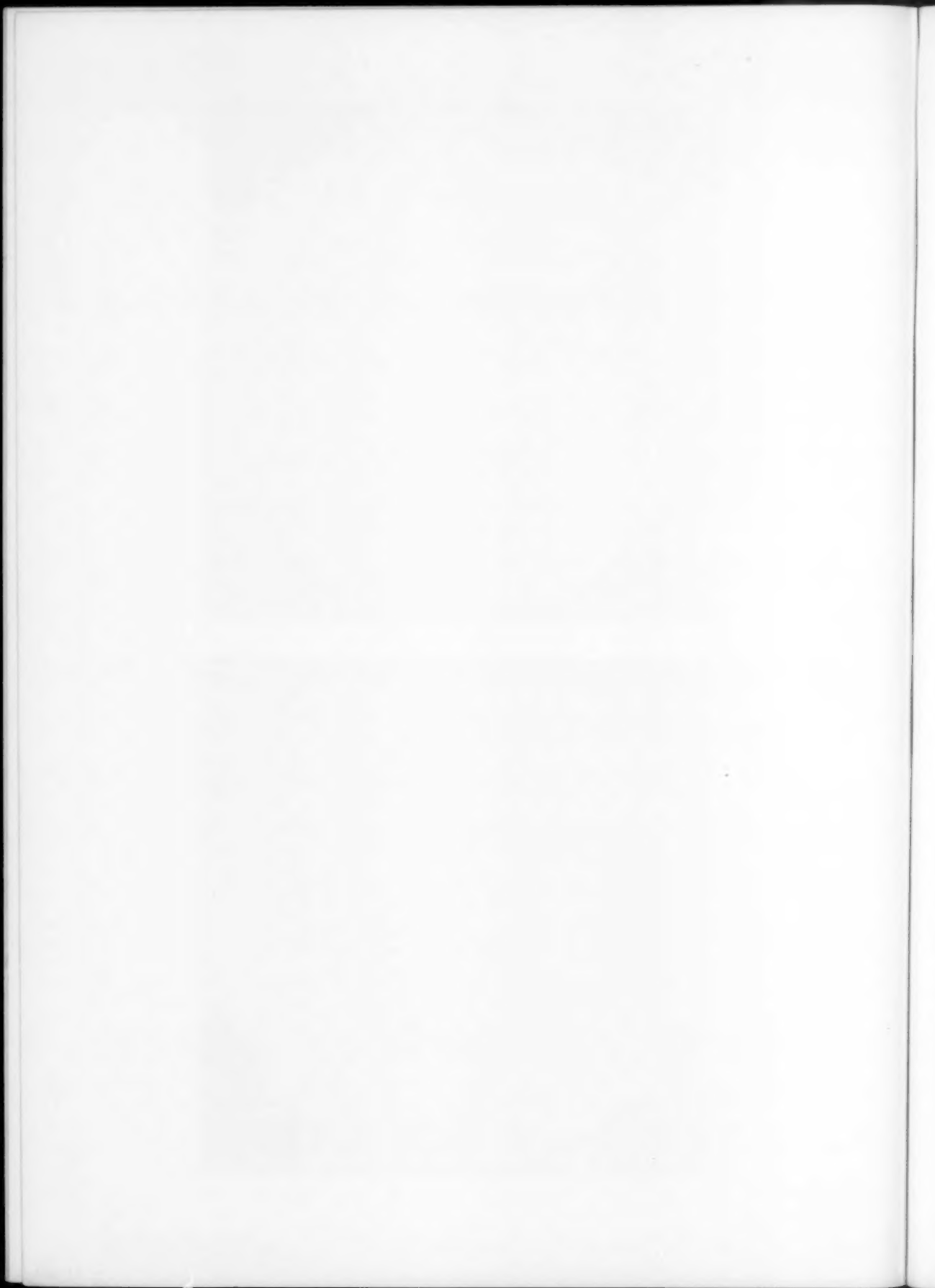


FIG. 6.—Photomicrograph Case II, showing another area of myxomatous tissue. Note viridis and the stellate nuclei.



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an occasional mitotic figure. This was suggestive in the frozen section of a sarcomatous condition (see Fig. 3), but is not marked enough to be classed as such, and besides the clinical course of the case would practically rule out malignancy. No suggestion of any nerve tissue whatever was found in this section.

From the clinical picture and course and the pathological examination this tumor is to be classed as a false neuroma of the class neuro-fibro-myxoma, the fibrous tissue predominating.

CASE II.—A Mr. G. P., age forty-eight, white, was admitted to the Robert W. Long Hospital, January 12, 1916, complaining of a tumor in the right side of the neck. The tumor was present ten or twelve years ago. About two months ago the tumor gradually increased to the size of a goose egg and then slowly decreased to the size of a large hen's egg. Recently the patient has had a pain in the right scapular region and down the right arm. He described a tingling sensation in the fingers, giving very much the same sensation as being struck on the "crazy bone."

On examination there is a spindle-shaped tumor situated in the right side of the neck parallel to and beneath and anterior to the border of the trapezius muscle. The mass extends upward to the posterior border of the sternomastoid muscle at its mid-point and downward to the clavicle at the junction of the same with the trapezius. The tumor is firm, smooth, and not attached to the skin, but somewhat attached to the underlying structure. Other history and examination unimportant. Diagnosis: Solid tumor, either fibroma or myxofibroma, in contact with the superior part of the brachial plexus.

Operation January 17, 1916, by Dr. W. D. Gatch. Incision over the site of the tumor. The upper part of the tumor was dissected out. The lower part of the tumor was jelly like in consistency. Myxomatous material was found in a pocket which extended under the right clavicle and into the right axilla. This pocket was swabbed out with one per cent. iodine solution. One small gauze drain was inserted and the skin closed with silk. Recovery was uneventful and the patient was discharged January 26, 1916. Wound healed by primary intention and there was no motor or sensory disturbance in the affected side.

Specimen lab. No. 727. This tumor was from external appearance not very large, but at operation was found to be very extensive. It could not be enucleated as the other was. The upper portion, which was chiefly fibrous, was removed rather easily, but it was found to extend behind the clavicle down into the right axilla. This was removed piecemeal as far as possible. At the extreme distal extremity the tissue was so soft and gelatinous that it was almost entirely without body and had to be removed by swabbing it out with a sponge. On examination of the tissue from the proximal pole, it was found to be fibrous and to cut with considerable resistance. The lower pole resembled in substance Wharton's jelly.

On section, the tissue from the upper pole is found to be fibrous, and is dense, the bands of fibrous tissue being wavy and closely packed together with very long, curved nuclei, few in number (see Fig. 4).

Some of this has lost its fibrous character and has become homogeneous and hyaline. Toward the distal extremity the cellular material is still scant, but the picture is that of myxomatous tissue (see Figs. 5 and 6). The blood-vessel walls are thin. This must be regarded as a neuro-fibro-myxoma, in which the myxomatous tissue predominates.

*General Discussion.*—False neuromata are classed under the term neuromata, though their connective-tissue origin is apparent. Virchow, in his classification in 1863 in the *Die Geschweulste*, says that true neuromata do occur, but rarely, and then occur only in the sympathetic system. Von Recklinghausen regarded these various false neuromata as having histological unity and as being but different manifestations of essentially the same pathological changes in the nerve constituents. Heredity in the multiple neuromata is considered to play a very important rôle. Flemming and Marvin have recently reported three cases of false neuroma of the localized type which occurred in the same family. The hereditary tendency has not been noted in this type before. One of the two cases reported in this paper gave a history of having carcinoma in the family, but no neuromata. The framework of nerve tissue is connective tissue and may give rise to the same sort of tumors as it does elsewhere. These tumors are usually fibromata or myxomata, or a combination of the two. These may undergo degeneration, and become cystic or hemorrhagic. They usually develop slowly and occur far more frequently during middle life. There is a tendency to marked sensitiveness in the tumor mass itself. Trauma is said to be an important etiological factor. Both heredity and trauma as etiological factors are lacking in these two cases.

Various authors believe that benign fibrous or fibro-myxomatous tumors of nerve sheaths may undergo a malignant degeneration into sarcoma. It would seem to the writers of this article that the safest criteria of judging at the operating table, whether a single tumor of a nerve is malignant or not, are the following:

1. The duration of the tumor. If the tumor is of long duration, it is of course not likely to be malignant. Case I shows that even a sudden and rapid increase in size of a tumor which has been quiescent for years is not proof positive of malignancy.
2. The presence or absence of motor or sensory paralysis. This is a most valuable point. A nerve will withstand really a remarkable amount of stretching or pulling from a benign growth, but is quickly destroyed by the infiltration of its substance by a sarcoma. In both of our cases pain and the various other sensory disturbances were the only symptoms produced by the tumors.
3. The gross appearance of the growth when exposed. Case II shows that it may be possible to remove a pure myxoma of the sheath by simply wiping it away. The encapsulation of the fibrous portion of the tumor and the possibility of shelling the same from the centre of a nerve trunk would



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seem to be strong evidence of a benign growth, as is the lack of encapsulation with fixation of the growth to the contiguous structures strong evidence for sarcoma.

4. Our experience with these cases leads us to regard the microscopic study of the tumor, especially if such study is relied upon to the exclusion of other evidence, as apt to be misleading.

If after consideration of all evidence available the surgeon is still in doubt as to the nature of the growth, it is perhaps wisest to be conservative, especially if the growth is in a situation where its complete removal is difficult.

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**RUPTURED SPLEEN\***  
WITH REPORT OF THREE CASES  
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IN reporting these cases we wish to emphasize the fact that two of the men had spontaneous rupture, of normal spleens, so far as could be demonstrated by macroscopic and microscopic examination and careful history excluding malaria and other diseases likely to affect the spleen. The third case was from trauma. All cases showed similar symptoms and Case II was diagnosed by Major Francis and Case III by Colonel Metcalfe before operation. So sure were we of the condition to be encountered, that a high left rectus incision was made, and a splenectomy performed with recovery in each case. After detailing the cases we wish to briefly review the literature on the subject.

CASE I.—R. F. Sergeant, Co. "K," 14th Cavalry. Age twenty-one. White. Male. Two and three-twelfths years service. Born in Texas. Occupation farmer. Denied ever having used alcoholics.

*Previous Personal History:* Measles and pertussis in childhood. Influenza and pneumonia in October, 1918. Never any injuries or accidents. Denies venereal infection.

July 28, 1919, shortly after returning from morning drill at Fort Sam Houston, Texas, patient noticed a sudden severe pain in left side of abdomen. Had nausea and vomited twice. Brought direct to Hospital. Admitted to Hospital at 12:00 noon, July 28, 1919. Temperature 96.2, pulse 78 and very weak. Patient appeared in shock, pale and extremities cold. Patient suffering severe pain in left side of abdomen just opposite to umbilicus. At 4:30 P.M., same date, pain in left upper abdomen, paroxysmal in character. Maximum pain just to left of umbilicus. Temperature 99.9° rectal. Leucocyte count 25,000. Examination showed marked tenderness across upper abdomen, rather more marked to the left of mid line. No definite rigidity and no distention. More pain on inspiration and on moving. No urinary symptoms and no previous gastric symptoms. Patient examined by Major Francis about 4:30 P.M. The most prominent symptom noted was pain in left upper abdomen, radiating to left shoulder. Tenderness over left upper abdomen. Patient mentally bright and alert. No other pathology found. Exploratory laparotomy at 6:10 P.M., July 28, 1919. Peritoneal cavity full of free blood. Spleen found ruptured and was removed. Abdomen closed without drain-

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## RUPTURED SPLEEN

age. Operated by Major Erdman. Patient made uneventful recovery. Wassermann and urine examination negative.

CASE II.—J.F. Private, 12th Field Artillery. White. Twenty-one years of age. Soldier. Six months service. Family history negative. Previous personal history diseases of childhood only. No serious illness or injuries.

Patient while on stable police with other soldiers morning of June 3, 1921, became very thirsty and was not permitted to leave work to get a drink until later, when he drank a large quantity of cold water; soon afterwards he developed cramp-like pain in abdomen and felt dizzy; told sergeant in charge he was sick and was told to go to quarters. Was walking to quarters some distance away when patient states that he fainted but was soon able to proceed to quarters. Had pain in abdomen and left shoulder. Was seen by Medical Officer and sent to hospital as appendicitis suspect at 8:15 P.M. Examination of patient at receiving ward was negative for appendicitis and he was admitted to General Medical Ward and given routine treatment.

Morning of June 4th, patient up and around ward, but says he feels dizzy and has a little pain in abdomen. At 4:00 P.M. nurse's attention was called to patient now in bed, suffering intense pain in abdomen. Seen at once by Captain Fletcher and found to be in state of severe shock. Temperature 96, pulse 140, skin cold and moist. Presenting picture of hemorrhage. Had constant desire to evacuate his bowels, passing small dark-colored stools, no blood. Abdomen showed no distention or rigidity. Some dullness in sides of abdomen. Patient given 1000 c.c. of ten per cent. glucose solution intravenously. At 9:00 P.M. pulse 150, but good volume, given stimulants during night. The following morning, June 5th, general condition was slightly improved over evening, temperature 99, pulse 120. Still complaining of pain in abdomen and left shoulder. Abdomen showed more apparent dullness but no distention or rigidity. Condition of shock improved sufficiently to warrant operation. Operated 11:00 A.M. Left rectus, high incision. Abdominal cavity full of blood with large clot surrounding spleen. Rupture of dorsal surface of spleen. Spleen and blood clots removed. Cavity filled with normal saline and closed, without drainage. Operated by Colonel Metcalfe. Uneventful recovery.

CASE III.—M.T. Private, Co. "D," 3rd M.R.Bn. Age twenty-two. White. Four years' service. Birthplace Missouri.

*Previous Personal History:* Patient had measles when small. Never had any serious illness. Right forearm fractured in 1915, good recovery. Venereal history, denied.

On July 6, 1921 about 4 P.M. he was riding a motorcycle on race track preparing for the motorcycle races to be held on July 23rd. He was thrown from his machine, due to machine leaving the track and going over a bank. The patient was brought to this hospital at 6 P.M. same day. Had multiple small lacerations over face, hands and back. Complained of severe pain in left shoulder. Examination of shoulder negative. Abdomen board like rigidity throughout, evidence of small amount of free fluid in peritoneal cavity. Patient's pulse good volume, rate 96, respiration normal. General condition good. Watched until following day, when patient's only complaint was pain in left shoulder. Abdomen tender and rigid with some free fluid present. Diagnosis of ruptured spleen made and patient operated on 6 P.M., July 7th. High left rectus incision. Free blood in peritoneal cavity. Spleen showed transverse and stellate laceration. Spleen removed, abdominal cavity freed of blood clots, normal saline introduced, closed without drainage. Operated by Colonel Metcalfe. Recovery uneventful. Duty, August 12, 1921.

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## BLOOD PICTURE FOLLOWING SPLENECTOMY—R. P. CASE I.

	July 28.	August 4.	August 5.	August 6.	August 24.
Red Corpuscles .....		4,320,000			4,460,000
White Corpuscles .....	15,250	17,550	17,050	14,600	11,950
Hæmoglobin, Per cent. ....		80%			80%
Differential Count					
Small Mononuclears .....	15	23	15	13.5	20
Large Mononuclears .....	2		8.5	9.5	10
Transitionals .....		4	4	3.5	2
Polymorphonuclears .....	83	73	74.5	73.5	68
Eosinophiles .....		4	4	2	1
Neutrophiles .....	83	69	70.5	71	67
Basophiles .....			0	0.5	

## BLOOD EXAMINATION FOLLOWING SPLENECTOMY, CASE III

M.T. Private., Co. "L", 3rd M.R. Bn.

	July, 11, 1921.	July 14, 1921.	July 16, 1921.	July 18, 1921.
Red Corpuscles .....	4,450,000	3,740,000	4,280,000	4,130,000
White Corpuscles .....	14,300	35,150	19,050	13,350
Hæmoglobin, Per cent. ....	85	80	85	85
Differential Count				
Small Mononuclears .....	19	7	11	20
Large Mononuclears .....	4	0	4	1
Transitionals .....	6	3	10	18
Polymorphonuclears .....	70	90	75	64
Eosinophiles .....	6		4	2
Neutrophiles .....	65		70	62
Basophiles .....	0	0	1	0
	July 19, 1921.	July 23, 1921.	July 25, 1921.	Aug. 9, 1921.
Red Corpuscles .....	5,333,000	4,700,000	4,730,000	3,290,000
White Corpuscles .....	12,050	8,600	17,050	8,350
Hæmoglobin, Per cent. ....	85	85	85	85
Differential Count				
Small Mononuclears .....	25	27	18	32
Large Mononuclears .....	4	1	2	8
Transitionals .....	6	7	5	5
Polymorphonuclears .....	65	65	75	55
Eosinophiles .....	6	4	2	0
Neutrophiles .....	56	60	73	0
Basophiles .....	3	1	0	0

Commenting on the foregoing cases, it is interesting to note that two patients were twenty-one and one twenty-two years of age, young, healthy, robust soldiers. Without history of previous serious illness or injuries. Cases I and II were spontaneous ruptures and Case III followed trauma, but each showing symptoms of intra-abdominal hemorrhage, dizziness, faintness, shock, nausea and vomiting, some abdominal pain and tenderness, rigidity, marked in one case and slight in two, slight dulness in lower flank when turned on side, the tossing about of the patient, which is not present in ruptured bowel.

Each case was very restless and had what seems to us as almost a pathognomonic symptom, severe pain radiating to left shoulder, and in each

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instance the patient complained bitterly of this shoulder pain and when recovered from the anæsthetic remarked upon the relief of this left shoulder pain.

Case No. II, who had the dizzy and fainting spell, no doubt had a subcapsular hemorrhage sufficient to cause the faintness. Then he recovered from this and later from the intracapsular pressure, the capsule was ruptured and then he had his second spell of shock and revived by glucose injection sufficient for operation. In Volume I, *Sajous Analytic Cyclopedic of Practical Medicine*, he quotes that malarial spleens are more prone to laceration by trauma than healthy spleen. Very extensive lacerations may be followed by death before surgery can be employed.

Trendelenburg<sup>1</sup> states that vomiting is the most important guide to diagnosis of ruptured spleen, that simple contusion of the alimentary tract is rarely accompanied by vomiting. He further states that ruptured spleen is usually not diagnosed prior to laparotomy.

Watkins<sup>2</sup> states that the mortality following removal of a healthy spleen for rupture is 40 per cent., with the non-operative mortality probably 100 per cent.

Nystrom<sup>6</sup> reports three cases in which intestinal paresis was a prominent symptom.

Ross in the *ANNALS OF SURGERY* for July, 1908, summarizes splenic ruptures found in the literature as follows: Of 220 cases unoperated, 17 recovered, giving a mortality of 92.3 per cent. of 67 cases operated, 38 recovered and 29 died, giving a mortality of 43.3 per cent. In two cases the splenic laceration was repaired, one died and one recovered. In the splenectomies 13 of the patients had complicating injuries, from which nine died.

Sajous states that splenic laceration or punctures of the spleen if unoperated are usually followed by abscesses, which are very difficult to heal. In the Civil War 93 per cent. of gunshot wounds of the spleen were fatal, while in the World War in eight cases reported by Duval mortality was as low as 37.5 per cent. In *Progressive Medicine*, June, 1920, four cases reported by Willis<sup>3</sup> are quoted. One case complicated by cerebral concussion could not be operated upon, three of the patients complained of agonizing pain in the left shoulder, which was promptly relieved by splenectomy.

That several days may elapse before a ruptured spleen becomes manifest, due to the subcapsular hæmatoma, is conceded by all surgeons who have had these cases to treat.

One case of a spontaneous rupture of the spleen is reported by Shorten,<sup>4</sup> in *British Medical Journal*, in which a soldier of the British army was seized by severe pain while walking about, sudden vomiting with rigidity, free fluid in the abdomen, no localized symptoms. Splenectomy was followed by recovery. Gangeli reports a case of apparent recovery from a ruptured spleen, who after nineteen days left the hospital and returned later with a sudden severe pain and died with an abdomen full of blood. Connors reports in the



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ANNALS OF SURGERY for July, 1921, a case of spontaneous rupture of the spleen, which at operation showed a large subcapsular hæmatoma, which ruptured on manipulation, showing deep rents in the parenchyma.

Nolan and Watson<sup>6</sup> report on 30,000 malarial cases admitted to Colon Hospital in eight years; there were only three cases of spontaneous rupture of spleen.

Connor and Downes<sup>7</sup> reported a spontaneous rupture of a typhoid spleen and were able to collect only twelve other cases.

Fauntleroy<sup>8</sup> reports a case who experienced severe pain, left shoulder, and attaches great importance to this symptom, which was relieved by operation. This same symptom was reported as present in the case of Connor and Downes.

In each of our cases we have made careful blood studies, which show a considerable increase of the total leucocyte count following splenectomy, which persists with more or less irregularity for a period of one to two months. Case I was extensively studied with reference to the blood and leucocytes following splenectomy and reported by Major Milton W. Hall, in the *American Journal of Medical Sciences*, July, 1920. From the study of the three cases above reported and those reported by others, especially the four cases reported by Willis, the one by Fauntleroy and one by Connor and Downes the following conclusions are drawn:

1. That the healthy spleen may rupture spontaneously or by comparatively slight trauma.

2. That the symptoms at first may be slight, some dizziness, nausea or vomiting with restlessness and indefinite abdominal pains or we may have immediate symptoms of severe intra-abdominal hemorrhage depending on whether the capsule of the spleen has ruptured or remains intact, forming a large subcapsular hæmatoma.

3. That with our three cases, three of Willis', one of Fauntleroy's and one of Connor and Downes, an agonizing pain was experienced in the left shoulder, and we believe that if evidence of this radiating pain from the splenic region to the left shoulder can be elicited in any indefinite abdominal case with evidence of hemorrhage, that one may safely conclude that he has a ruptured or lacerated spleen to deal with.

4. That in view of the high mortality of unoperated cases, we believe that the only safe treatment is immediate splenectomy.

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## CYSTIC DILATATION OF THE COMMON BILE DUCT

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THE literature records but thirty-six cases of cyst of the common bile duct. The condition must indeed be rare since McConnell (Dublin) in a review of the literature covering the past one hundred years states: "It is of interest, however, to note that the first case resembling the one described was a patient in Whitworth Hospital in 1817." The marked progress of abdominal surgery during the past few decades does not seem to have increased the frequency of cystic changes found in the biliary passages. The term cyst in its true sense, when applied to the common bile duct, is descriptive but does not adequately convey the nature of the anatomic pathology found present. In all probability the condition is not a cyst but a diverticulum of the duct and should be so designated.

In reviewing the cases reported we were impressed with the fact that some of these may also have involved biliary passages other than the common bile duct. This factor may be applied to the case under discussion, but inasmuch as we cannot definitely prove or rule out either, it might be well to include this case under the classification of the cyst or diverticulum of the common bile duct.

In consideration of the rare occurrence of this condition it would seem advisable to report each case encountered, with the hope that repeated investigation will cast more light upon its pathogenesis.

Mrs. E. E., white, aged fifty-six years, nativity American, and occupation a domestic, was admitted to the service of Doctor Rind of the City Hospital, Springfield, Ohio, April, 1920. Her chief complaint consisted in an enlargement of the upper abdomen, associated with a dull aching pain which radiated to the back. Her family history was negative. The patient stated that she first noticed a slight swelling in the epigastrium at the age of twenty years which increased steadily but very slowly in size for twenty-eight years or until 1912. There had been no pain up to this time, when upon undue exertion she felt a "giving way" sensation in the region of the swelling, and states, that since that time, the tumor has increased rapidly in size, and has been accompanied by pain. She has had marked intermittent jaundice during the past four years. The patient has a poor appetite and states that practically all food "sours" in the stomach, producing a large amount of gas.

Physical examination revealed a middle-aged female first seen lying in bed and apparently suffering no acute distress. Her complexion was "muddy" or turbid. Nothing of note was found in the head, neck, or chest. The abdomen was greatly distended. This enlargement was more prominent than is usual in a full-term pregnancy. The disten-

tion could be palpated as a non-movable tense mass. Manipulation did not produce pain. The mass was distinctly dull upon percussion and transmitted a "muffled" wave of fluctuation. In general outline the enlargement seemed to occupy the entire upper abdomen with considerable extension below the umbilicus.

X-ray examination revealed a large shadow extending upwards, pushing the diaphragm and liver as high as the eighth interspace. The urine showed an abundance of albumin with a few hyaline and granular casts and a trace of bile.

Operation revealed an enormous cyst, practically extending as far as the examining hand could reach. The cyst wall was found to be adherent to every adjacent organ including the stomach, pancreas, liver, intestine, and portions of the parietal peritoneum. During the necessary manipulation in an attempt to discover the origin of the cyst the wall was accidentally ruptured, allowing a sudden gush of approximately eight litres of a thin greenish-yellow fluid. The sudden release of intra-abdominal pressure caused quite a marked reaction in the patient's condition and necessitated a rapid examination of the abdomen which revealed dense adhesions between the cyst, the aorta and vena cava. This prohibited a possible chance of complete dissection at this time. While the other abdominal viscera were displaced they were apparently normal in so far as could be determined by a rather hurried examination. A considerable portion of the anterior wall of the cyst was removed. A large rubber drainage tube was sutured in the remainder and the abdomen was closed.

The immediate post-operative convalescence was uneventful. The patient continued to drain a large amount of the cystic fluid for three weeks when the wound healed. Shortly after this she developed a small abscess to the right of the incision, which was drained with immediate relief of the local reaction. This opening persisted through January, 1921, draining a small amount of clear straw-colored fluid. The patient was at that time other than for the presence of the draining wound enjoying excellent health, having been freed entirely from her symptoms prior to operation.

Gross examination of the portion of the cyst wall excised reveals a thin sheet-like mass of tissue varying from 0.25 cm. to 1 cm. in thickness, averaging approximately 0.5 cm. One surface is covered with peritoneum scattered over which is found evidence of old adhesions. The opposite or inner surface is wrinkled, soft and dull in appearance, presenting numerous areas which are brownish in color. These areas appear and feel velvety. In its general consistency this portion of the cyst wall seems fibrous and strong.

Microscopically the inner surface is composed of a single layer of well-defined columnar epithelium resting upon a rather substantial submucous coat of connective tissue. Within this fibrous wall are found occasional cross-sections of small openings lined with a single layer of columnar cells resembling very closely the structure of the smaller bile ducts found within the liver. Here also are encountered occasional areas of liver substance, and what appear to be perfectly normal liver lobules can be demonstrated.



FIG. 1.—Low power photomicrograph showing lining membrane of cyst wall composed of columnar epithelium.

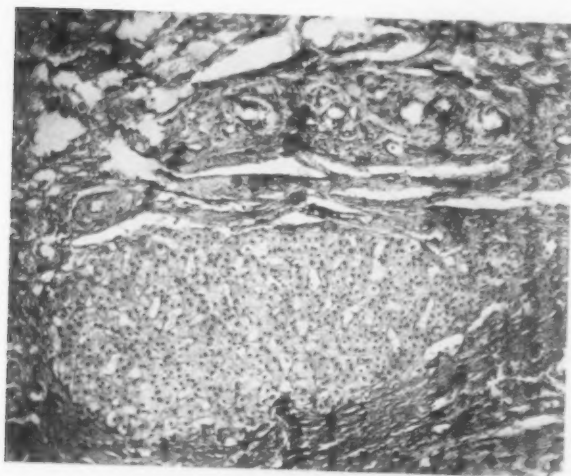


FIG. 2.—Low power photomicrograph showing portion of liver tissue within wall of cyst.

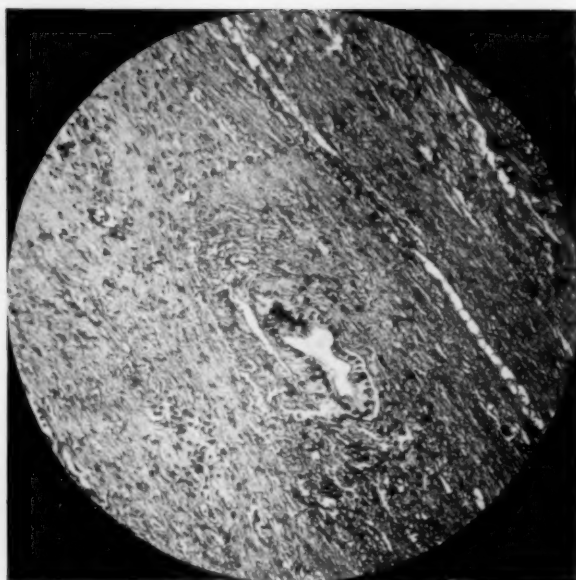


FIG. 3.—Low power photomicrograph showing cross section of what appears to be a slightly dilated biliary duct.

## CYSTIC DILATATION OF THE COMMON BILE DUCT

It would seem that the cyst either had its origin within the liver or the enlargement having been primarily periglandular had encroached upon the liver substance and thinning it out by pressure until this excised portion at least contained some much thinned out liver tissue.

Waller, in a recent discussion of this condition, mentions as a possible etiological factor, the presence of a valve-like fold in the mucous membrane associated with a kink in the lower end of the duct. This remains closed until sufficient intra-cystic pressure is accumulated by the secreted bile to force the fold to one side or obliterate it. This temporarily releases the pressure contained within the walls of the cyst to the point when the valve-like arrangement can reform. He states that "the above-described valve formation gives sufficient explanation of the question, why the fully formed cyst cannot empty itself, and why it undergoes an ever increasing enlargement of volume. But it is impossible to suppose that the valve can be developed until a part of the duct has widened into a sac-like cavity and the existence of the valve is therefore not sufficient to explain what causes the first enlargement."

Congenital malformation of the duct would seem to be a plausible explanation. Heiliger in 1910 found a decided distention in an almost mature foetus at autopsy. With the exception of our case, the condition has always been found in childhood or young adult life. Of the thirty-six cases reported the youngest was two years and the oldest twenty-five years of age. Our patient, although fifty-six years of age, first noticed the swelling of the epigastrium thirty-six years before, or at the age of twenty. In analyzing the reported cases it is evident that should the condition exist from the time of birth it does not necessarily follow that it should show immediate symptoms. "On the contrary, all observations seem to indicate that it is in the beginning absolutely latent to its owner." This period of latency varied with different individuals, and coupled with the fact that the cyst is apparently ever increasing in size, it would seem that the first symptoms would in the main depend upon not only its anatomical arrangement, but the size of the foetal diverticulum. If at the time of birth the sac is well developed, the symptoms may arise in the very young, otherwise it would seem the patient may be free from any disturbance until sufficient dilatation of the cyst is reached to seriously interfere with biliary function and drainage.

The not infrequent dilatations of the common duct occurring secondary to purely mechanical diseases of the gall-passages or pancreas, as a rule convert the duct into a cylindrical tube, retaining its original shape, and even when of long standing seldom if ever exceeding the diameter of the small intestine. The conditions presenting in the subject under discussion differ markedly in that the enlargement involves only the upper and middle thirds of the duct. In most instances the cases reported record enlargements of about the size of a child's or man's head. In our case the cyst was much larger, containing approximately 7 or 8 litres of fluid.

With regard to the treatment, an investigation of the reported cases would



seem to indicate that simple drainage of the cyst is inadequate. Twenty-one out of thirty-two cases treated by drainage with the production of an external fistula died following operation, the time elapsing between operation and death in most instances being but a few days. Three of these cases lived from one to three months after operation. The cause of death in these cases was the development of an acute purpuric condition or a sudden fatal hemorrhage. One case recurred three years after operation with the formation of a fistula; the patient, however, dying of tuberculosis. McConnell reports in his table a case having been drained on two separate occasions with the patient living three years and eight months after the last operation, the fistula closing two years and eight months after the second drainage.\* The conditions met at the time of operation of our case necessitated the institution of drainage in order to shorten the operation because of the sudden collapse of the patient while on the table. Here instead of suturing the cyst wall to the abdomen as had been practiced in the above cases, a large rubber tube was inserted within the cavity and brought out through the incision. The uneventful convalescence in this case was an agreeable surprise.

In the remaining eleven cases treated surgically, three of these in which drainage was followed by an attempt at choldochenterostomy resulted fatally. Three of these in which drainage was followed by successful choldochenterostomy recovered. Extirpation of the cyst was performed in three cases, all of which died. Two cases in which primary operation consisted of choldochenterostomy have lived.

1st Op.	2nd Op.	No. of cases	died	Recurrences and Remarks
Drainage		19	18	One recurred 3 yrs. with fistula and died with tbc. One case with fistula at end of 9 months.
Drainage and Choldochenterostomy		1	1	
Drainage	Drainage	1	0	Living 3 years 8 months, fistula closed 2 yrs. 8 months.
Drainage	Attempt at Choldochenterostomy	3	3	0
Drainage	Attempt at Choldochenterostomy	3	0	3
Extirpation		3	3	0
Choldochenterostomy		2	0	2
Unoperated		4		
Fœtus		1		
Totals		37	25	7

\* McConnell (British Journal of Surgery, April, 1920, p. 523). Our case has been added to the list of patients having had drainage in first operation, making the total number of cases recorded to date 37.



## CYSTIC DILATATION OF THE COMMON BILE DUCT

### SUMMARY

By the way of summary it is of interest to note that during the past century with its phenomenal development of abdominal surgery there has been no apparent increase in the percentage of the occurrence of this condition. The preoperative diagnosis has never been recorded due no doubt to its rare incidence. The striking clinical feature present in practically each case reported has been intermittent jaundice in the child or young adult usually associated with some form of palpable tumor mass in the upper right quadrant of the abdomen. It would seem that cystic dilatation of the bile passages should be considered in the differential diagnosis when the above-mentioned clinical symptoms are encountered.

The case serving as a basis for this discussion is a female, aged fifty-six. Her symptoms, however, were noticed at the age of twenty. Since this time her main discomfort having been gastric disturbance, intermittent jaundice, pain, and tumor formation. So far as we have been able to determine, this is the oldest patient reported in the literature with this condition. The cyst containing approximately 8 litres is in all probability the largest on record. The patient at the present time (September 1, 1921) is enjoying good health and is able to attend to her household duties, the wound having healed.

We wish to express our appreciation to Doctor Rind for the privilege of studying this most interesting case.

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## SOME PROBLEMS IN CONNECTION WITH THE SURGERY OF THE BILIARY TRACT\*

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THE advances that have been made in the surgical treatment of diseases of the biliary tract are a source of satisfaction to all of us, but those most skilled in gall-bladder surgery are readiest to admit that the limit of attainment is still far from having been reached. Rational treatment presupposes accurate diagnosis. Unfortunately, the recognition of gall-bladder disease is often accompanied by difficulties, though we have at our disposal every refinement of diagnostic aid. A complete history, a careful physical examination; a thorough röntgenological study are of great value, but they do not always enable us to ascertain the exact condition existing in the biliary passages. The use of the duodenal tube and magnesium sulphate, according to the technic developed by Lyon,<sup>6</sup> is probably a valuable procedure, but it cannot tell us whether we have calculi or not; in other words, through its use we are not always able to determine whether the case is one likely to be benefited by further medical treatment or whether immediate surgical intervention is desirable. Even after opening the abdomen and exposing the gall-bladder, I am sometimes unable to state whether it is the seat of a pathological process or not; and it has been a source of chagrin to me that on several occasions I have failed to detect the pathology of certain gall-bladders removed by other surgeons. The presence of calculi, thickening and contraction of the gall-bladder walls, the enlargement of the lymphatic glands, these are all fairly obvious indications of disease of the gall-bladder; but, unfortunately, they are sometimes absent in patients with a history suggestive of gall-bladder infection. C. H. Mayo<sup>7</sup> has emphasized the desirability of early diagnosis of cholecystitis, in order that suitable surgical measures may be instituted and the patient saved from the danger of serious complicating disease. While this is a most laudable object, its pursuit may result in subjecting a considerable number of patients to needless surgical mutilation.

The rank and file of surgeons are influenced by the attitude of the leaders in the profession, and we have seen instances of too enthusiastic adoption of the suggestion of these leaders by men who are lacking in the judgment and skill that the former possess. All of us have probably encountered instances where the optimistic surgeon has removed the appendix for the relief of obscure abdominal discomfort, but where neither the subsequent history of the patient nor the report of the pathologist served to justify this course. Over forty years ago Dr. Alexander Goodell<sup>8</sup> protested against needless pelvic operations on female patients, and it has seemed to me that we would do well

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to remember the following words from his pen: "As the Angels, according to the Schoolmen of the middle ages, fly from point to point without traversing the intervening distance, so, with like swiftness, the physician of the present day jumps from any distinctively female ache to an ovarian conclusion." Far be it from me to attempt to belittle the importance of early operation in cases of gall-bladder infection; the unfortunate results of delay are too well recognized for any intelligent surgeon to advise it, but, at the risk of incurring the suspicion of envying a colleague's diagnostic skill, I cannot forbear feeling a little skepticism when there are reported by some operators such a large preponderance of the cases of simple cholecystitis as compared to those accompanied by calculi. Is there not a possibility that the surgeon of the present day is becoming a little prone to draw a gall-bladder conclusion from any upper abdominal discomfort? With me this is a distinct problem; we find ourselves between the two horns of a dilemma; on the one hand, we wish our patient to derive the benefit of early operation; but, on the other hand, we encounter the difficulty of making a positive diagnosis in these early cases.

Having demonstrated the existence of a pathological process in the gall-bladder, the next problem we encounter is in regard to the manner of treatment. Disregarding medical methods, it is felt in the great majority of clinics that the decision must be made between retention of the gall-bladder with drainage or a removal of that organ. To acknowledge changing views as to the relative value of these two operative measures may be done with impunity; such a course has been rendered fashionable by most of the shining lights of the profession. I had satisfied myself that cholecystectomy was the operation of choice, to be performed in all cases of cholecystitis unless there existed a definite contra-indication, but of recent years, I have come to feel that the decision is not always so simple as we could wish.

In the first place, it has been clearly demonstrated that the gall-bladder normally performs two definite functions, namely, the concentration and the storage of the bile, both of which may play a rôle of importance in the digestive processes. Though it has been shown by Judd<sup>5</sup> and others that patients may enjoy apparent good health for years after a cholecystectomy, nevertheless we should hesitate to remove an organ that normally exercises very definite functions. Of course there are conditions which clearly indicate removal of the gall-bladder; the presence of a malignant growth, hydrops of the gall-bladder, cicatricial closure of the cystic duct, and the so-called strawberry gall-bladder; in such cases the only rational procedure is cholecystectomy, provided the condition of the patient justify undertaking the operation.

In the practice of every surgeon who does much gall-bladder work, there will be encountered certain patients, in whom the diseased condition has persisted for a considerable period of time. Many of these patients are at an advanced age; they may be overweight; and there is evidence of marked myocardial and renal involvement; they may be weakened by repeated exacerbations of the infectious process in the gall-bladder and ducts; jaundice of

long duration is not infrequently encountered. Not only is the patient's general state poor, but the local condition around the gall-bladder is such as to cause much anxiety. Dense adhesions bind the various structures together, interfering with proper function and distorting the anatomical picture so as to prevent a satisfactory palpation of the ducts. The gall-bladder may show thickened, contracted walls, or it may be distended with pus.

What course are we to follow in such cases as these? Does it not seem wisest to remove the gall-bladder which is probably the chief seat of the infection responsible for all the damage? From inspection, one can scarcely hope to see it ever again perform its normal function. It has been my experience, however, that in many of these cases cholecystectomy will prove disappointing and the results of cholecystostomy are surprisingly good. One reason for this is to be found in the general condition of the patient, this being so poor that many of them are unable to survive the relatively severe operation of cholecystectomy, while the milder cholecystostomy, a less trying tax on their strength, does not lead to a fatal outcome or the injury of important structures. It must be admitted that the necessity for secondary operations arises less often after cholecystectomy than after cholecystostomy; in other words, the morbidity after the former operation is less, from a quantitative standpoint, than is the case after the latter. But is this morbidity after cholecystectomy less severe when it does occur? My experience has led me to the contrary conclusion. While I have not been so unfortunate as to cut a common duct during the course of a cholecystectomy, it would seem that this is not the universal experience, judging by the number of papers dealing with methods of repair that have recently appeared in the literature. Then, too, secondary operations are occasionally necessary after cholecystectomy. Even the skilled operator may overlook common duct stones, and they may form in the ducts after removal of the gall-bladder. Everyone who has had to go in again and endeavor to locate an obstructing calculus after removal of the gall-bladder will agree with me that it is immeasurably more difficult and dangerous than is the case when the gall-bladder is present to serve as a guide and landmark. Finally, it is surprising to what an extent these apparently hopelessly crippled gall-bladders will recover after drainage, so that even those apparently most severely involved will eventually regain at least a part of their functional capacity. It is true that later a cholecystectomy may be found necessary, but it is usually the case that the performance of the preliminary cholecystostomy with the consequent relief of the pressing symptoms renders the patient a far better surgical risk than he was when first encountered.

I am sure that my attitude in advocating cholecystostomy and drainage in these severe cases of gall-bladder involvement will subject me to criticism; I am equally certain that my views in regard to the method of treatment of another type of case will call down condemnation on my head. What measures are we to adopt in dealing with a patient in whose gall-bladder there are apparently sterile calculi? What course shall we follow when we encounter



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a case of low-grade cholecystitis, where we can demonstrate no bacteria or where the few found are of a very low degree of virulence? Often the discomfort experienced by patients with these conditions is slight; minor digestive disturbances, the eructation of gas, usually no attacks of severe colic; and it is possible that such conditions and symptoms may persist until the patient succumb at a ripe old age from some other cause than the gall-bladder disease. I believe that there are some surgeons, at least, who would advocate the drainage of such gall-bladders as I have described; feeling that it is unjustifiable to sacrifice an organ whose functional ability has been so little impaired. My experience has been, however, that in such cases as these, cholecystostomy with drainage, instead of yielding the desired relief, often renders the patient much more miserable than he was before falling into the hands of the surgeon. Impressed by such observations, we have sought the explanation, and we believe it is to be found in the results of certain animal experiments<sup>12</sup> that we have performed. We have, on numerous occasions, been able to show that sterile bile allowed to escape into the peritoneal cavity does not exert the lethal action that some authors would have us believe; moreover, it does not seem to call forth the production of dense adhesions. If, however, a foreign body be introduced into the cavity along with the bile, the character of the resulting adhesions is altered; they become much more numerous and dense. If, finally, infected bile plus a foreign body be introduced, there result adhesions of a density seen after no other intra-abdominal procedure with which I am familiar. How may these experimental observations be used to explain our clinical disappointments? In the praiseworthy attempt to drain away the infecting organisms and the remnants of calculi, we introduce a drain, our foreign body. It is indeed a moot point as to whether drainage is always effective in removing infectious material from the abdominal cavity; there is no question but that we introduce infectious material into this cavity when we allow a drain, extending from the exterior, to remain in it for any length of time. Fortunately, owing to the defensive powers of the peritoneum, this infection is not disseminated, but becomes localized, the adhesions serving to confine it to the region of the gall-bladder. These adhesions, though probably responsible for saving the patient's life, later often render this life scarcely worth the living. As Deaver<sup>3</sup> so aptly expresses it in speaking of adhesions: "In many cases the symptoms and gravity of gall-bladder lesions are due, not to the gall-bladder affection *per se*, but to the accompanying adhesions." Again, in a later paper,<sup>2</sup> he states: "I believe that pericholecystic adhesions, the result of gall-bladder and duct infection, often give a clinical picture which is identical with that found in gall-stone disease, and do so in the entire absence of gall-stones at any time; and, after operation, they are capable of causing symptoms which mimic gall-stone colic."

Such considerations as these have led me to take what appears to be an extremely radical position. If these mildly affected gall-bladders are to be treated either by cholecystostomy with drainage or by cholecystectomy, I

unhesitatingly commit myself as favoring the latter, because I am convinced that a great majority of patients suffering from such a mild degree of gall-bladder involvement are rendered worse by the improperly termed "milder" operation of cholecystostomy with drainage. The attitude that the surgical profession as a whole has taken forced me into this position; there is no half-way ground; as treated in most progressive clinics, these patients are subjected either to a cholecystectomy or to a cholecystostomy with drainage.

In 1912 I became impressed with the fact that practically none of our patients gave any evidence of leakage of bile after the performance of the classical cholecystectomy with the insertion of drainage. If leakage did not occur, why would it not be safe to dispense with the drainage? At the time, I was unaware that such omission had been practiced years before; some of the foreign surgeons having obtained results, even with a comparatively crude technic, which seem amply to justify a more extended trial of this method of procedure.

After five years' experience with cholecystectomy without drainage performed in the most favorable type of cases, I reported<sup>10</sup> the results that I had obtained in a series of thirty-eight cases, where drainage was omitted after removal of the gall-bladder. Of this number one patient succumbed, but neither in this fatal case nor in any of the others was there any indication of leakage of bile. Since the appearance of my paper, Richter<sup>9</sup> has adopted my suggestion; and, still more recently, Bottomley<sup>1</sup> has expressed his approval of the omission of drainage in certain cases of cholecystectomy and has stated that he has obtained excellent results by such omission. Last year I was able to report<sup>11</sup> the results that I had obtained by a more extended trial of this method, and showed that of a series of seventy-two patients, death occurred in only two instances. Both of the fatal cases came to autopsy and in neither was there the slightest evidence of bile leakage. These results seemed amply to justify the conclusion that: "the omission of drainage after the majority of operations of cholecystectomy is a procedure that is perfectly safe; and the results obtained by such omission are distinctly superior to those following the older method of packing or draining with gauze." It must be understood, therefore, that in advocating cholecystectomy in preference to cholecystostomy with drainage in the treatment of these mild cases of gall-bladder disease, I am referring to cholecystectomy without drainage; for, if drainage be used after cholecystectomy, we produce many of the same crippling adhesions that follow cholecystostomy with drainage.

But are we forced to choose between the removal of an organ that normally performs a definite function and a retention of that organ only at the expense of producing adhesions which impair its function and may render the condition of the patient more unsatisfactory than it was before operation?

In 1883 Meredith performed the so-called "ideal" cholecystotomy. In this operation the gall-bladder is opened, the calculi removed, the incision in the gall-bladder sutured, and the abdomen closed. The operation has re-



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ceived the condemnation of succeeding generations of surgeons, and the following emphatic statement of Moynihan<sup>8</sup> in regard to it illustrates the attitude of most modern operators: "Ideal cholecystotomy is anything but ideal in practice, and is an operation that is mentioned now only that it may be unequivocally condemned."

Faith is at times indeed a virtue. Blind faith, the passive acceptance of the views of the recognized leaders may, however, retard our progress, and it has seemed to me that in the sweeping condemnation of the "ideal" cholecystotomy, we have been guilty of such an error as this. It is easy to understand how in the earlier days of biliary surgery, with a poorly developed technic and less diagnostic skill, the performance of cholecystotomy without drainage on unsuitable cases led to disaster. But is not the condition different now? Is it not a well-known fact that many patients come to the surgeon with only moderate lesions in the gall-bladder? In such cases as I have already described, where there are no viable organisms, where the calculi are practically only sterile foreign bodies and where we can detect no pathological changes in the gall-bladder, why should it not be practicable to open the gall-bladder, remove the calculi, and close without drainage? Is such a course much more radical than the omission of drainage after the repair of a perforating duodenal ulcer, or after removal of a renal calculus? Finally, why should the omission of drainage after cholecystotomy on these selected cases be accompanied by any more danger than such omission after cholecystectomy? At the time of my first paper the omission of drainage after cholecystectomy was a procedure looked on askance; now it is coming to be widely practiced. Moreover, Richter<sup>9</sup> has revived the old practice of omitting drainage after choledochotomy, with apparently excellent results. If, therefore, the "ideal" operation be practicable, there is offered us a middle course to be followed in certain selected cases; cases where there is a low-grade infection or no infection at all, where the gall-bladder shows no demonstrable evidence of pathological changes, and, presumably, has suffered no alteration of its functional ability. Would it not be immeasurably better if we could preserve such a gall-bladder after removing the calculi which might later, if allowed to remain, give rise to obstruction or, acting as irritants lead to a fresh invasion of the gall-bladder by pathologic organisms?<sup>†</sup>

The work of Lyon in effecting non-surgical drainage of the biliary passages seems to be full of promise as an adjunct to this "ideal" operation. After the removal of the calculi the patient may be subjected to a course of treatment as outlined by Lyon, and, by this means, it would seem that any infection that might be left in the gall-bladder could be removed through the duodenum. By following out such a plan as this, we can probably preserve a functionally unimpaired organ without subjecting the patient to

<sup>†</sup> I am familiar with the work of Rosenow and others, in which pathogenic organisms were demonstrated in the wall of the gall-bladder, but it would seem to me unusual, to say the least, for these organisms to remain in the wall of the organ without appearing free in the bile.

the danger, nay, probability of adhesion formation with resulting discomfort and disability greater than that which existed before operative measures were undertaken, and by so doing, it would seem that we are taking a definite step forward in the development of biliary surgery. I am practicing cholecystotomy in selected cases and believe it has a distinct field of usefulness in surgery of the gall-bladder.

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## THE RESULTS OF HIGH LIGATION OF THE CYSTIC DUCT IN CHOLECYSTECTOMY\*

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IN this paper we shall not discuss the indications of the operation, but we shall endeavor to show what happens after the operation has been performed. The results of this operation are much more important from the standpoint of the physiology of the biliary system than from the standpoint of anatomy, hence we shall pass over the latter. The experimental work reported in this paper was done in the Laboratory of Surgical Research of the University in 1916 and 1917; the War prevented the publication of the results. In spite of the delay and the fact that similar work has been done elsewhere since the work upon which this paper is based was carried out, we have thought the subject of sufficient importance to warrant this presentation.

First of all let us consider what is the normal physiology of the gall-bladder. That the gall-bladder is an organ essential to life or health, or that it has a specific function has not as yet been proved. Hohlweg<sup>1</sup> considers that while the gall-bladder is an important organ, it is not a vital one.

Woods Hutchinson<sup>2</sup> after post-mortem studies thought the gall-bladder was practically a functionless organ and probably vestigial. The chief objection to regarding the gall-bladder as vestigial resides in his mind that we have no certain evidence of its ever having had a function whose value was in any way compensatory for the dangers to which it exposed its possessor. It has this much title to recognition as of some vital importance in that it appears at an early period in the development of the liver. From the beginning it displays irregularities as to shape and size, and also that it is found in some animals and not in others. With this record of inconstancy, it can hardly be asserted that the gall-bladder exercises any very vital or important function. He is of the opinion that the gall-bladder is nearly a functionless organ.

The physiologists as well as surgeons, such as Deaver and Ashhurst<sup>3</sup> and others, are of the opinion that the gall-bladder has a function, and when we admit it has a function we are compelled to admit, that that function, whatever it may be, should be conserved. That the gall-bladder has a function of storing bile there can be no doubt. Starling<sup>4</sup> claims the exigencies of the body require a continuous excretion of bile by the liver, but a discontinuous entry of this fluid into the small intestine. This discontinuity into the intestines is secured in the majority of animals by the existence

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of the gall-bladder, a diverticulum from the bile ducts, in which all bile secreted during the intervals between the periods of digestive activity is stored up. Magie<sup>6</sup> has never seen an empty or collapsed gall-bladder when examining it during the course of operations in the upper abdomen. The fact that it is always filled with bile goes to prove that it has much to do with keeping up and regulating the pressure in the bile ducts and liver. Lapenta<sup>6</sup> is of the same opinion. Judd<sup>7</sup> and Gillette<sup>8</sup> compare the gall-bladder to a tension bulb acting as a regulator of the flow of bile. Of course the sphincter of Oddi is also concerned in the pressure of bile in the biliary system, as well as the rate of bile secretion. The escape of bile into duodenum is at least partially under the control of the sphincter of Oddi, thus the fluctuation of intra duct pressure is in all probability compensated by the gall-bladder. Kemp,<sup>9</sup> Leede,<sup>10</sup> Lamson<sup>11</sup> and others regard the gall-bladder as a secretory organ which elaborates and adds something that is of importance either to the general body economy or to the mechanism of bile expulsion or chemical action.

Going on the hypothesis that the gall-bladder has some definite function, the question arose, "what would be the effect on the biliary system after cholecystectomy with a high ligation of the cystic duct?" This suggestion was presented to us by Dr. Joshua E. Sweet, the Director of the Laboratory, after he had observed a slight enlargement just proximal to a ligature placed about the cystic duct. This observation was made post mortem about three weeks after the ligature had been put around the cystic duct.

We used a series of dogs on which we performed cholecystectomy employing the following technic; the dog was anæsthetized with ether and the abdomen opened by a right rectus incision. On exposing the gall-bladder the fundus was caught with a hæmostat and drawn upward, thus putting the cystic, hepatic and common ducts on tension. The length and diameter of the cystic duct was then measured. With an aneurism needle a ligature was passed about the cystic duct and artery below the neck of the gall-bladder. The ligature was tied and the neck of the gall-bladder was grasped with a curved hæmostat and divided between the hæmostat and ligature. The gall-bladder was then carefully dissected out from below upwards and removed. No attempt was made to close or drain the gall-bladder fossa. The wound was closed in the usual manner without drainage. The length of the cystic duct stump varied from 6 mm. to 2 cm. in length, and the diameter was approximately 2 mm.

Of the ten dogs operated, one died during the operation, and the others recovered. Those that recovered were chloroformed and autopsied at intervals varying from six weeks to fourteen weeks after operation. In a dog, six weeks after operation, in which a duct 6 mm. in length was left, we found a small bud-like dilation at the end of the cystic duct stump. This dilation was filled with bile. The common and hepatic ducts were somewhat dilated.

In seven of the other eight dogs, we found dilation of the cystic duct stump quite marked. In some the cystic duct stumps had increased in length from

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1.2 cm. to 2.5 cm. and were 1 cm. in diameter. They were all filled with bile.

On histological examination of a section from these newly formed bladders all the coats of the gall-bladder could be recognized. The histology of the cystic duct resembles so strongly that of the gall-bladder that we cannot definitely state whether there was simply dilation of the duct or a true reformation of the gall-bladder. If it is simply a dilation of the duct there is certainly some hypertrophy, for the walls of the newly-formed sac are thicker than a pure dilation would permit and, moreover the layers do not show the thinning and stretching such as a pure dilation due to mechanical means would permit without true hypertrophy.

One dog in which the cystic duct was cut off practically flush with the common duct showed no dilation of the small stump, but exhibited a marked dilation of the common and hepatic ducts. In two of the eight cases with dilation, the bile had become inspissated and apparently was beginning to form calculi. A microscopic study of these dilations was that of a chronic catarrhal cholecystitis. It seems the dilation had not the power to force the bile out.

Looking over the literature, we find that dilation of the cystic duct following removal of the gall-bladder in dogs was first done by Zambecari. It was later corroborated by Oddi<sup>12</sup> in 1889, DeVogt<sup>13</sup> in 1898, Von Haberer and Clairmont<sup>14</sup> in 1904, Andrews,<sup>15</sup> Eisendrath and Dunlavy,<sup>16</sup> and others. Lapenta<sup>9</sup> removed the gall-bladders from ten dogs. Twenty to sixty days following the operation, the abdomen was opened to examine the condition of the common duct. In every case the duct was dilated and in two dogs the stump of the cystic had dilated in bulb fashion, showing the attempt of nature to restore the function of the gall-bladder, whatever that may be.

That the stump of the cystic duct dilates in a certain number of cases there is no doubt. Kadian<sup>17</sup> reports a case of gall-stones with cholecystectomy, and six years later there was a return of symptoms. The second operation showed the cystic duct was dilated and contained several cholesterol stones. He found twenty-eight cases in the literature similar to his own. Von Haberer<sup>14</sup> reported a case in which gall-stone formation had taken place. Kehr<sup>18</sup> reports having removed a cystic duct stump that had attained a length of ten centimetres. Floercken<sup>19</sup> found a dilation of the cystic duct the size of a plum three years after cholecystectomy, and a brown calculus embedded in the wall of the dilation and none elsewhere. Eisendrath<sup>20</sup> reports the following case: Patient had a cholecystectomy performed by another surgeon in 1910 at which time a small, hard gall-bladder containing two large calculi were found. Fragments of calculi and sandy detritus were also found in the cystic duct. Two years later there was a return of pain accompanied by icterus. At a second operation by Eisendrath at this time, the cystic duct was found to be dilated, forming a pseudo gall-bladder two and one-half centimetres long, containing a calculus the size of a millet seed.

In addition we wish to report the following cases:



CASE I.—Through the courtesy of the late Professor Francis E. Stewart, of the Jefferson Medical College, we cite the following: The patient was operated on by Doctor Stewart on November 29, 1915, at which time a cholecystectomy was performed. No stones were found at operation, but the histological examination of the gall-bladder was that of a chronic catarrhal cholecystitis. She recovered from the operation and was free of all symptoms until February, 1916, when she was taken with sudden attacks of upper abdominal pain severe in nature. This attack was attended by nausea and vomiting and required morphine for the relief of pain. The attack lasted for about two hours and was not followed by jaundice. The attacks occurred independent of the taking of food, some occurring while asleep at night and others while engaged in her household duties. The pain as a rule disappeared between attacks and never radiated away from the upper right abdominal quadrant. On admission to the hospital the physical examination was negative, except for marked tenderness over the gall-bladder region. No distinct mass was felt. Laparotomy was performed by Doctor Stewart September 28, 1916, which disclosed a mass of adhesions of the colon to the anterior abdominal wall, from the stomach to the edge of the liver, and a small hard mass at the right of the gall-bladder which had been removed at the previous operation. No stones were felt in the dome of the liver or in the common duct. The mass was incised and a quantity of bile and mucus escaped. A probe inserted into the opening could be passed upward into the liver and downward into the common duct. The opening was drained and the patient discharged much improved on October 22, 1916.

CASE II.—By permission of Dr. John B. Deaver, from his service at the University Hospital. M. E. S., age sixty. Appendectomy ten years ago, cholecystectomy four years ago, chronic colitis. Patient is laid up two or three days out of every week with pain in the abdomen and vomiting. The vomitus contains food ingested twelve to sixteen hours before. The pain is of a colicky nature. The attacks do not seem related to any particular kind or quantity of food. They usually come on after the patient has retired. Examination of the stomach contents showed a high acidity and retention. No blood. Examination of the stool was negative. A gastro-intestinal X-ray was advised but refused. A diagnosis of abdominal adhesions, causing pyloric obstruction, was made. Operation by Doctor Deaver disclosed many adhesions about the pylorus and upper bowel. At the site of ligation of the cystic duct there was an outpouching about four and a half centimetres in length. This was removed. On opening it, no stones were found, but it contained a large quantity of inspissated bile. This new growth was removed, ligating flush with the common duct. The transverse colon (after freeing many adhesions) was turned up and interposed between the stomach and liver. The abdomen was closed without drainage.

The patient had a somewhat stormy convalescence due to a pyelitis which developed, but eventually recovered.

Twenty-two months have elapsed since the operation, during which time the patient has been free from any abdominal discomfort.



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### CONCLUSIONS

1. Where a cystic duct stump is left, it usually dilates to form a pseudo gall-bladder; hence we may get a recurrence of the symptoms after a cholecystectomy.
2. Where the cystic duct is ligated flush with the common duct, there is general dilation of all ducts, indicating that there is pressure in the biliary system.
3. The gall-bladder is not essential to life, but it seems to have a very definite function of storing bile and acting as a tension bulb to regulate pressure in the biliary system.
4. Nature endeavors to restore the normal condition in the biliary system, after the removal of the gall-bladder by the ducts, including the cystic duct stump undergoing a dilation and enlarging. It is an indication that nature rebels against man's attempt to improve on her, hence the gall-bladder must have some definite function.

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**DUODENECTOMY**  
(AN EXPERIMENTAL STUDY)

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A PRELIMINARY report has been made of the results of our experiments dealing with the removal of the duodenum.<sup>1</sup> We are now submitting a further report of these experiments. The important physiologic and anatomic position of the duodenum and the desirability of determining whether it has a specific function or whether its physiologic action is merged with the rest of the gastro-intestinal tract were discussed in the preliminary report. It should be emphasized that our research deals also with the possible function of Brunner's glands.

REVIEW OF PREVIOUS WORK

A large number of experiments have been performed on the duodenum. The most important of these, and in fact the only ones presenting definite data, were published after our investigation had been started. The first experiments on the removal of the duodenum were performed in an attempt to determine the relative part the duodenum and pancreas might have in the production of experimental diabetes. The most important of these researches are those of Benzi and Reale,<sup>2</sup> Pflüger,<sup>3</sup> Ehrmann,<sup>4</sup> Lauwens,<sup>5</sup> Minkowski,<sup>6</sup> Cimatori,<sup>7</sup> Tiberti,<sup>8</sup> Rosenberg,<sup>9</sup> and Bickel.<sup>10</sup>

Benzi and Reale partially removed the duodenum in dogs, that is, they resected the portion not attached to the pancreas. By this method neither the common bile duct nor the pancreatic ducts were in any way molested and, on the other hand, none of Brunner's glands was removed.

Pflüger removed the duodenum and small intestine from frogs and dogs. In the latter species he performed the same operation that Benzi and Reale performed, that is, only a partial resection of the duodenum.

Ehrmann removed the duodenum from several dogs. The jejunum was anastomosed to the stomach. The pancreatic ducts were either ligated or implanted with the common bile duct into the stomach. The animals survived from a few days to a week, death evidently being due to or associated with trauma to the pancreas because widespread fat necrosis was always present.

Lauwens operated on several dogs. In five he made a gastro-enterostomy, transplanted the common bile duct with the minor pancreatic duct and a small amount of duodenal mucosa into the stomach, ligated the major pancreatic duct, and removed the duodenum. Four of

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the dogs died the first day after operation, and one lived until the thirteenth day. The other two animals were operated on in a similar manner, except that the common bile and minor pancreatic ducts were transplanted to the skin. One of these animals died on the ninth day, and one was still alive on the thirteenth day.

Minkowski successfully removed the duodenum from two dogs. This seems to be the first successful duodenectomy. The continuity of the gastrointestinal canal was established by a gastroenterostomy. Bile flow was maintained by a cholecystenterostomy. The animals seem to have remained well, but since the investigator was interested in diabetes, the pancreas was removed in each animal and further data with regard to the duodenum were not given.

Cimoroni removed the duodenum from dogs in a one-stage operation. The pylorus, duodenum, and the first portion of the jejunum were removed. The jejunum was anastomosed to the stomach either by the regular posterior gastroenterostomy technic, or by a Murphy button. The pancreatic ducts were tied and the common bile duct transplanted to the skin. Most of the dogs died immediately after operation. Four of them lived eleven, seven, six, and six days, respectively.

Tiberti removed the duodenum from nine dogs. He varied the type of operation. In three dogs he removed the duodenum, made a gastroenterostomy and transplanted the bile duct to the skin; in two, enteroanastomosis was made; in two, enteroanastomosis and cholecystenterostomy, and in two, the operation was complicated by the removal of a portion of the pancreas. None of the animals lived very long after the operation, the longest period being five days.

Rosenberg removed the duodenum, although not completely, from five dogs. He performed gastroenterostomy and cholecystenterostomy, and ligated the pancreatic ducts. Four of the animals died shortly after the operation; one was still alive on the twenty-third day.

Bickel removed the duodenum from two dogs. He performed gastroenterostomy and transplanted the common bile duct and pancreatic duct to the skin. One of the animals lived ten days and the other four and a half weeks.

Gaultier<sup>11</sup> studied the effect of injury by caustics to the duodenal mucosa in animals, and Zak<sup>12</sup> reported two observations on the effect of caustics on the duodenum in man. Herlitzka<sup>13</sup> observed the effect of the injection of vaselin and nicotin into the duodenum of frogs.

Maury,<sup>14</sup> in an extensive research on high obstruction, concluded that the duodenal epithelium contained something of great importance to life, and particularly with regard to the toxic condition of obstruction. Matthews,<sup>15</sup> on the basis of Maury's conclusions, performed several series of experiments in which the duodenum and jejunum were isolated and drained by various combinations of methods. From the results of these experiments he concludes that the removal of the duodenum is incompatible with life longer than seventy-two hours.

Stasoff<sup>16</sup> studied the effect of removal of various portions of the gastrointestinal tract. None of the animals in which he removed the entire duodenum survived. He was able to keep one animal alive in

which the portion of the duodenum distal to the entrance of the common bile duct was resected.

Dragstedt, Dragstedt, McClintock and Chase<sup>17</sup> studied the effect of duodenectomy in two series of dogs. In eleven dogs the operation was performed in two stages. At the first operation the pylorus was divided, both ends closed, and an anterior gastroenterostomy made with the middle jejunum. After the animals recovered from the first operation, a second was performed and the duodenum removed as far as the gastroenterostomy. The bile and pancreatic ducts were tied and the gall-bladder drained, in some cases into the jejunum, in others externally. Most of these dogs died within two or three days after the last operation; one lived twelve days. At necropsy a widespread, intra-abdominal fat necrosis was usually found. In one series of five dogs the common bile duct was ligated and sectioned, the pylorus divided, the pancreas opposite the pylorus ligated and divided with a cautery, and the entire duodenum with the adherent pancreas as well as the upper jejunum removed. The middle jejunum was sutured to the divided pylorus, and the gall-bladder drained. Most of these animals died on the fifth or sixth day, but one lived three weeks and one three months. The dog that survived three months, however, showed very marked nutritional disturbances and was kept alive for that period only by careful feeding and special attention.

Grey<sup>18</sup> removed the duodenum in three stages, allowing an interval of several weeks between each stage. The first stage consisted of dividing the common bile duct between ligatures and anastomosing the gall-bladder to the proximal jejunum. After the animal had recovered, the second stage was performed. This consisted of isolating the major pancreatic duct and transplanting it into the jejunum a short distance from the site of the cholecystenterostomy opening. At the same time the minor pancreatic duct was ligated and sectioned. At the third stage the duodenum was removed.

Many animals succumbed at various stages of the operation, but one survived all three operations and lived in a normal condition for nine and one-half months after the total removal of the duodenum; it then died suddenly, apparently from intestinal obstruction following adhesions.

Moorhead and Landes<sup>19</sup> also removed the duodenum of the dog in three stages. In the first stage the pylorus was sectioned, the duodenal end invaginated and closed and the proximal jejunum anastomosed to the gastric end. Two weeks later the common bile duct and major pancreatic duct were transplanted into the jejunum just distal to the gastrojejunal anastomosis. After another interval of two weeks the duodenum was removed. Only the mucosa was removed from the pancreatic portion of the duodenum. Dogs operated on in this manner lived in a normal state of health.

A few general statements are justified from this brief review of the data of previous workers on the effects of duodenectomy. As I have stated, the first investigators were interested in the problem only as it might affect the

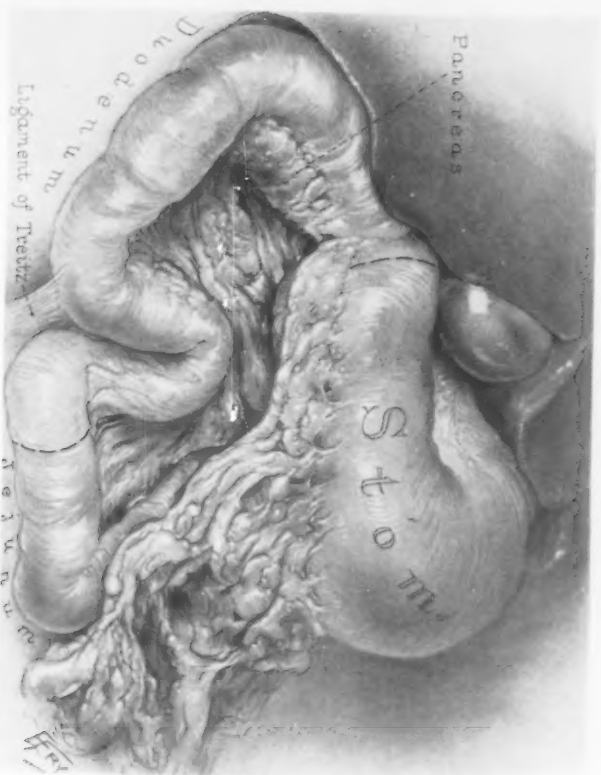


FIG. 1.—The anatomic relationship of the duodenum in the dog. The portion to be resected is included between the dotted lines.

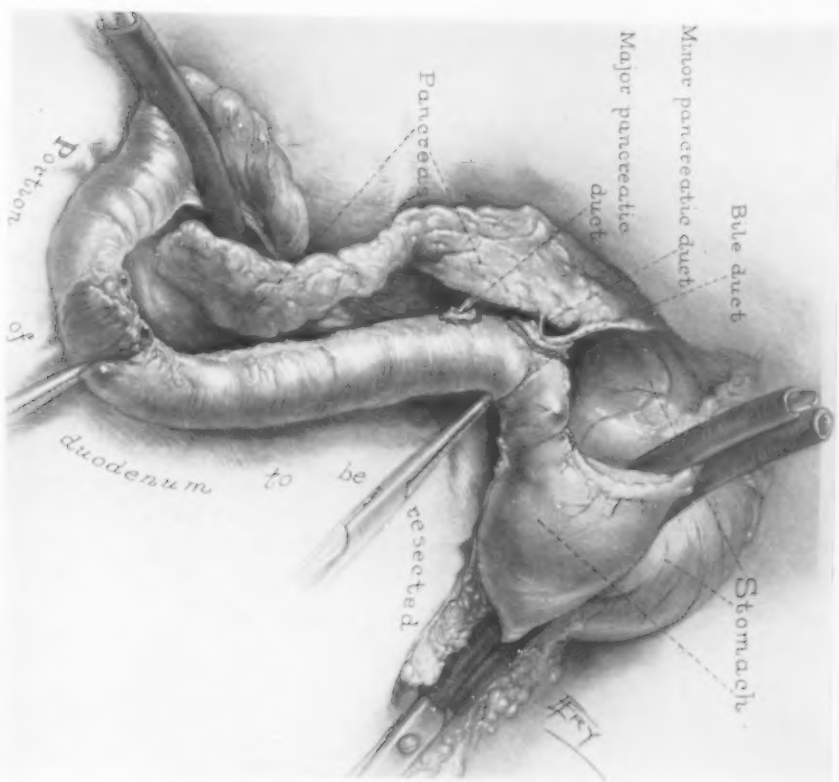


FIG. 2.—The duodenum of the dog, before resection and after complete separation from its ligaments, blood vessels, and pancreas. The ducts are completely isolated and ready to be sectioned just as they pass through the mucosa of the duodenum.





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problem of experimental diabetes. Only a very small percentage of their animals lived after the operation. In most of the few that survived the duodenum was not removed completely, and in the very few instances in which it seemed reasonably certain that the complete extirpation would be successful, the duodenal phase of the experiment was sacrificed for the pancreatic phase.

It does not seem that experiments dealing with the short-circuiting of any particular portion of the gastrointestinal tract parallel those in which the same portion has been removed surgically. Many of the short-circuiting operations produce toxic conditions. For that reason the experiments of Matthews should be classified with those on intestinal obstruction and not on duodenectomy.

The last three investigators proved that a dog could live, at least for a relatively short time, after duodenectomy. Dragstedt and his collaborators clearly showed that the dog can survive duodenectomy, but their work is open to the same objections as that of many of the earlier workers, that the duodenectomy was complicated by a loss of pancreatic function, and in some instances, of function of the bile. The results of Grey, one of whose animals lived the longest after duodenectomy, and the results of Moorhead and Landes prove that duodenectomy is compatible with life and perfect health in the dog for relatively short periods.

### TECHNIC OF REMOVING THE DUODENUM

In our first experiments we attempted to follow the technic employed by previous workers in which two-stage or three-stage operations were performed. This attempt proved as fruitless in our hands as in the hands of others; it seemed as if only a small percentage of animals would live after the second or third operation. We then devised a one-stage operation, after the plan of the two-stage operation. Most of the operations performed by this method were partial or complete failures, the animals dying because of the long operation or from intercurrent disease. One animal lived seventeen days and died from intussusception of the small intestine. One in which the pancreatic ducts were ligated lived forty-one days (Protocol 1).

Because of the unfavorable results, a one-stage operation consisting of four steps was developed: (1) dissection of the duodenojejunal fold, mesoduodenum and lesser omentum, and ligation of the blood-vessels supplying the upper jejunum and duodenum; (2) separation of the pancreas from the duodenum and isolation of the major pancreatic duct and the common bile duct, together with the lesser pancreatic duct; (3) removal of the entire duodenum in connection with a portion of the proximal jejunum and distal pyloric portion of the stomach; and (4) implantation of the bile duct together with the minor and the major pancreatic ducts into the jejunum. By this method the duodenectomy can be performed quickly, and the other organs involved, such as the bile duct, both pancreatic ducts, the pancreas, and the alimentary tract, can be restored, as nearly as possible, to the normal state (Figs. 6 and 7).

The animal was fasted for twenty-four hours. Ether anaesthesia was employed and all operations were performed with aseptic technic. The duodenum was exposed through a right rectus or midline incision (Fig. 1). The duodenojejunal juncture was found and the duodenojejunal fold cut. The branches of the mesenteric vessels, usually three or four, which run to the distal duodenum and proximal jejunum, were doubly ligated and sectioned. This procedure mobilized the proximal portion of the jejunum. The mesoduodenum was cut to the point where the pancreas becomes adherent to the duodenum. In order that the subsequent gastrojejunal anastomosis might be performed with ease, the lesser omentum was partially divided; usually it was also necessary to ligate and section several blood-vessels.

The common bile ducts and the pancreatic ducts were located and exposed. The bile duct and minor pancreatic duct, together or close to each other, open into the duodenum from 5 to 8 cm. from the pylorus, and the major pancreatic duct opens from 2.5 to 5 cm. distally. After exposure of the ducts the duodenum was carefully but boldly dissected from the pancreas, beginning at the caudal end. The branches of the pancreatic-duodenal vessels which enter the duodenum from the pancreas were tied with fine silk or catgut ligatures and divided close to the former. The bile duct passes behind the duodenum, perforates the muscular coat of the latter, and, after running for 1 cm. or more in the submucosa, opens into the bowel, closely associated with the minor pancreatic duct. An aneurism needle was placed under the exposed portion of the duct, placing it on a tension. The muscular coat of the duodenum along both sides of the entire course of the duct was incised longitudinally with a small sharp-pointed scalpel and the duct perfectly isolated up to its orifice. The same procedure was repeated on each of the pancreatic ducts. At this point of the operation the duodenum was free with the exception of its attachment to the stomach and jejunum and to the bile and pancreatic ducts (Fig. 2). Various methods were tried of treating the orifices of the ducts. By far the easiest method consisted of excising and leaving a small ring of duodenal mucosa around the duct. Owing to the disturbance of the circulation this little piece of mucosa always appeared dark red, and it seemed reasonable to suppose that it would not live. However, since such a method involves a careful histologic examination of the orifice of the ducts at necropsy in order definitely to determine that no duodenal mucosa is present, it seemed best to devise a technic which would be free from such suspicion. In a few operations we followed the method of previous operators and thoroughly scraped off the mucosa. The serious objection to this method is that scraping the mucosa is liable to cause contamination. The method which was found most satisfactory, and which obviated the possibility of contamination and the danger of leaving duodenal mucosa, is as follows:

The muscularis of the duodenal wall is cut about 1 cm. from the opening of the duct in the bowel and pushed back, making a cuff around the duct which extends toward the lumen of the duodenum. The duct is then sectioned just at its point of entrance into the bowel. In this

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manner the lumen of the duodenum is not entered and duodenal mucosa is not attached to the ducts. The minor pancreatic duct can usually be freed with the bile duct. Rarely is it necessary to cut the former because of an anomaly in position. It is very important that during the manipulation the pancreas is kept warm and well protected from contamination and drying. All unnecessary trauma must be avoided. The vessels supplying the duodenal wall must be ligated and divided close to the duodenal wall. Many of the failures recorded by other

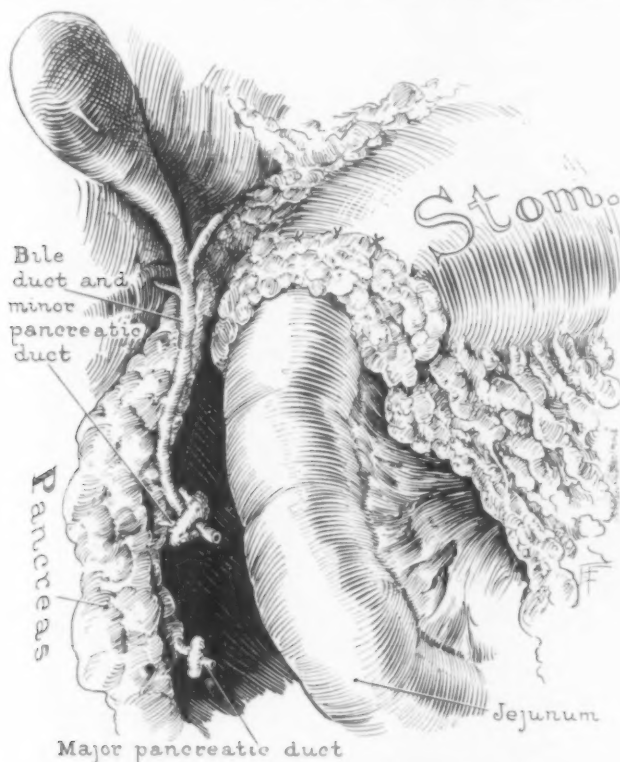


FIG. 3.—The duodenum resected and the jejunum anastomosed to the pyloric end of the stomach. The next step in the operation is the transplantation of the ducts. Note the cuff of muscle around each duct.

investigators and a few of our own have been due to trauma of the pancreas.

The next step in the operation is the removal of the entire duodenum. Rubber-covered clamps are placed on the stomach and the jejunum. The entire segment of the bowel from which the blood supply has been ligated is removed. This includes a segment of the pyloric region of the stomach (1 or 2 cm. proximal to the pyloric ring), the entire duodenum, and from 10 to 15 cm. of the proximal jejunum. The continuity of the intestinal canal is restored by direct anastomosis of the opened end of the stomach to the sectioned jejunum. Thus a segment of the jejunum occupies the exact site which had been occupied by the duodenum (Fig. 3).

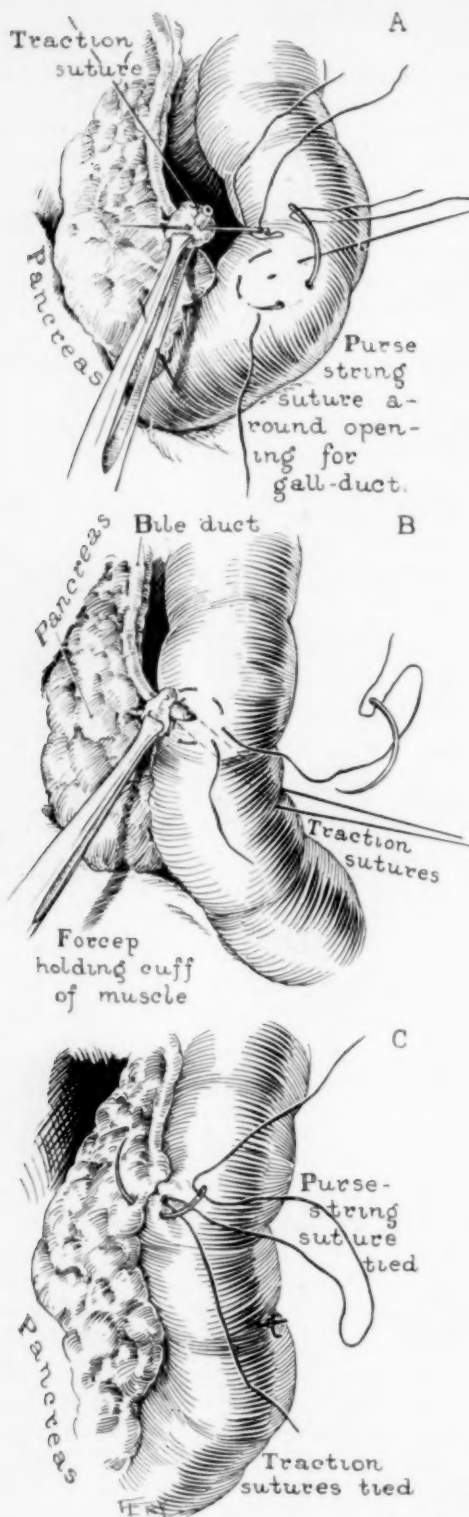


FIG. 4.—Steps in the transplantation of the ducts. A, traction and purse-string sutures in position. B, the duct being pulled into the jejunum. C, the transplantation completed.

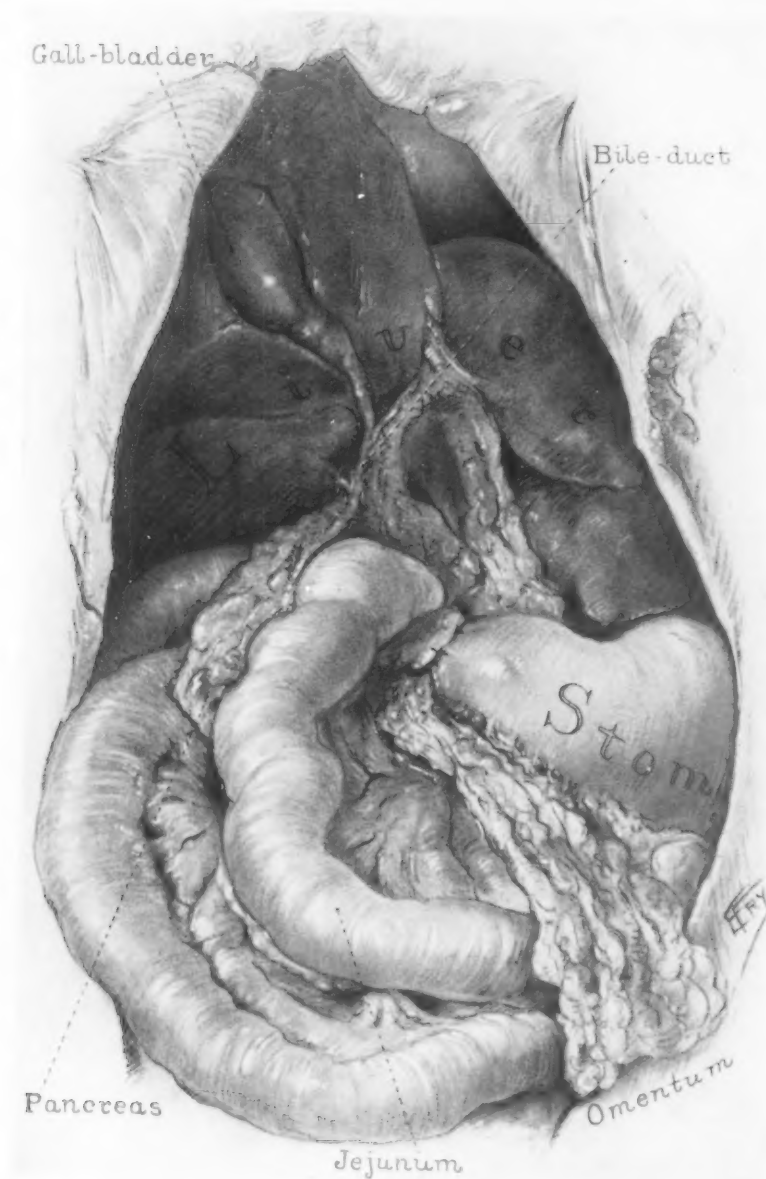


FIG. 5.—The operation completed in the dog. The jejunum occupies the position previously occupied by the duodenum. An almost complete reconstruction of the gastro-intestinal tract has been accomplished. The sites of transplantation of the ducts are marked by the indentation of the contour of the jejunum.

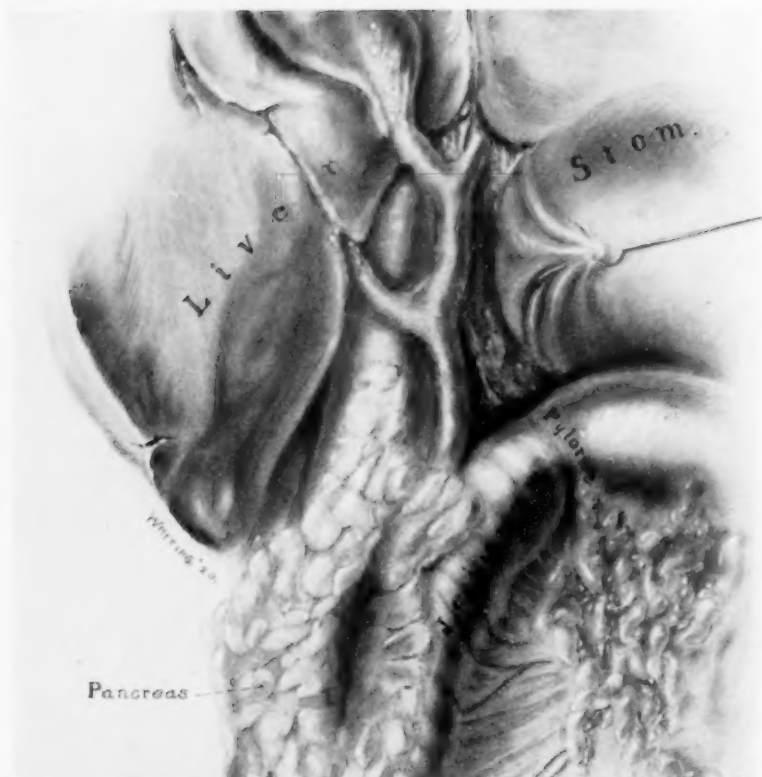


FIG. 6.—(Dog D. 37). The site of operation at necropsy 490 days after duodenectomy. Grossly the pancreas and liver appear to be normal. The extrahepatic biliary tract is slightly dilated and the walls thickened. The gastrojejunal anastomosis is hardly discernible. (Operation by Kawamura).



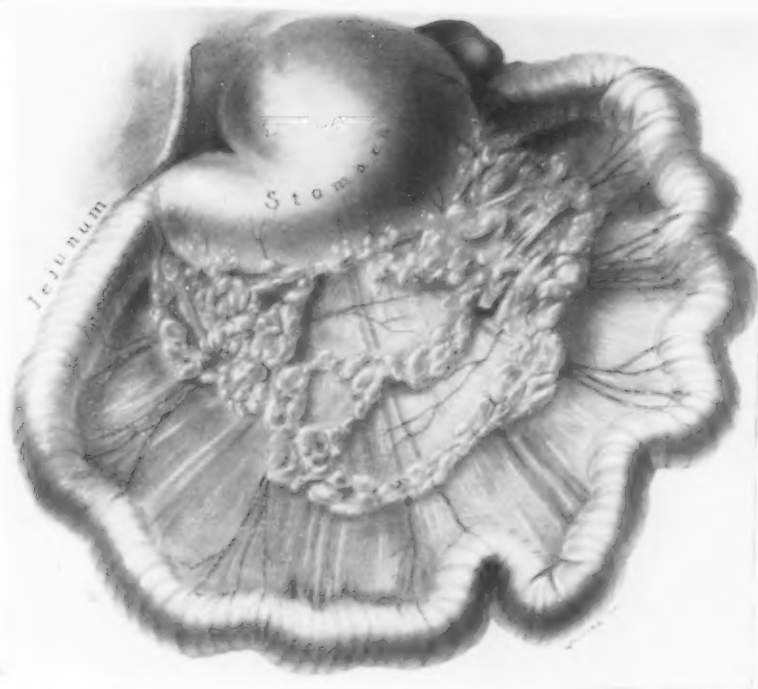


FIG. 7.—(Dog D. 37). The stomach and jejunum 400 days after duodenectomy. The chief evidence of the absence of the duodenum is that the loop of intestine proximal to the stomach has a free mesentery, that is, the ligament of Treitz is absent. (Operation by Kawamura.)

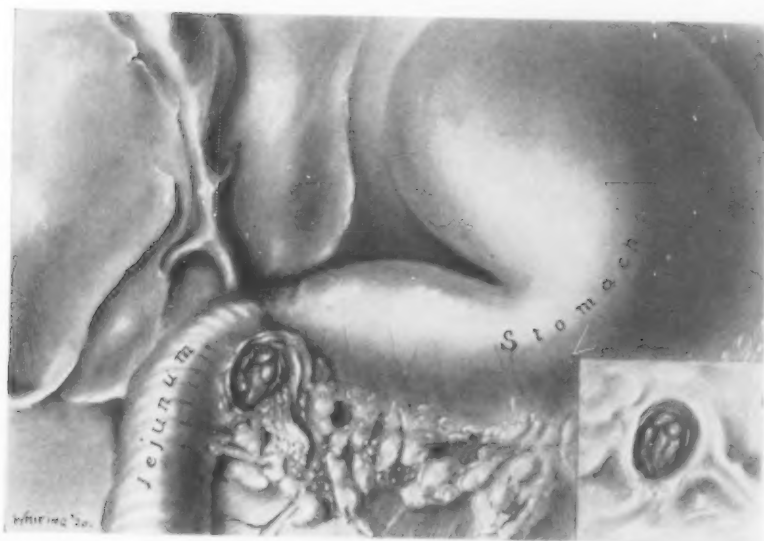


FIG. 8.—(Dog C. 991). A perforating ulcer on the jejunal side of the suture line which produced peritonitis and death 515 days after duodenectomy.



FIG 9.—(Dog C. 919). A deep ulcer on the jejunal side of the suture line, noted at necropsy, 393 days after duodenectomy. The ulcer had penetrated to the muscularis and had a hard base. The opening of the common bile duct is at a, the opening of the pancreatic duct at b.



FIG. 10.—(Dog C. 878). Duodenectomy two years and six months before. The animal appears the same as before operation.



FIG. 11.—(Hog 1). Thirty days after duodenectomy; animal weighs 27.5 kg. Compare with Figure 12.

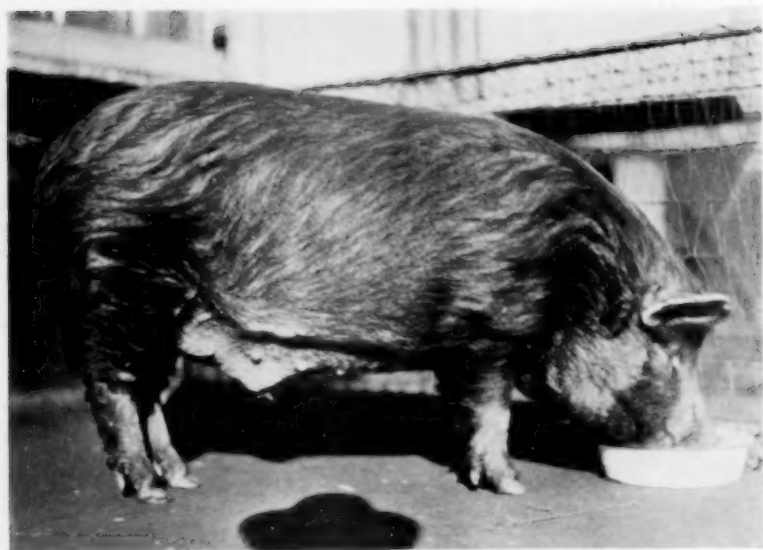


FIG. 12.—(Hog 1). Three hundred two days after duodenectomy; animal weighs 130 kg. Compare with Figure 11.

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The final step in the operation is to transplant the ducts. Two guides of No. 00 plain catgut threaded on straight cambric needles are attached on opposite sides of each duct (the minor pancreatic duct is included with the bile duct). A site on the wall of the portion of the jejunum which occupies the position of the duodenum is selected to prevent tension on the ducts. At this site, which is at about one-third the circumference of the jejunum from the mesenteric attachment, a purse-string suture of No. 00 catgut is placed. The purse-string forms a circle of about 8 mm. in diameter. With a sharp-pointed knife the centre is pierced and the opening enlarged by stretching with a sharp-pointed forceps to equal the diameter of the duct. Through this opening the needles of the guides are passed and pierce the opposite side of the bowel about 2 cm. below their entrance and about 0.5 cm. apart. The duct is drawn into the lumen of the jejunum and the guides tied. The purse-string suture is tied and, if necessary, a few additional sutures are taken and a tag of omentum sutured around the duct (Fig. 4). When this is finished the bowel is slightly constricted, but it is always patent for the passage of gas and liquids (Fig. 5). The constriction disappears when the fine catgut is absorbed. The muscularis which is left around the duct serves to plug the opening through which it has been drawn.

There are many possibilities for technical errors. In our experiments the failures have been due to: (1) too small an opening of the anastomosis of the jejunum to the stomach; (2) suturing the common bile duct too firmly in the intestinal wall, producing partial obstruction; and (3) trauma to the pancreas (this error only occurred in cats). It is interesting to note that we rarely had a failure of the transplantation of the pancreatic duct in this series of experiments.

### RESULTS OF REMOVAL OF THE DUODENUM IN VARIOUS SPECIES OF ANIMALS

With slight modifications in the technic described, necessary because of anatomic variations in the different species of animals, the duodenum was removed from five species—dog, cat, hog, goat, and monkey. The best results were obtained in the dog, cat, and hog, and conclusions are based on the data obtained from the experiments on these three species.

*The Dog.*—Most of the experiments were performed on the dog and, since the technic was devised mainly for the dog, it was carried out exactly as described. Our observations included: (1) The general condition of the animal; (2) the movements of the gastrointestinal tract; and (3) the secretory activity of the stomach. We had also planned to study the secretion of the pancreas and liver, but as a few preliminary observations made it quite evident that the loss of the duodenum would not produce so great a change, if any, in the secretory activity of these glands, as the transplantation of their ducts, we did not make any extensive observations.\*

We have not been able to show that the removal of the duodenum in the dog, unaccompanied by sequelæ of errors of the technic of the operation, in any way affects the life or general health of the animal except in relation

\* Our observations on the secretory activity of the stomach are not completed.

to the possibility of ulcer. All the animals in which the operation was technically perfect remained in seemingly normal condition. The appetite was always good; the weight did not vary any more than in laboratory dogs not operated on; nothing was noted which could be attributed to the loss of the duodenum (Protocol 2).

A few of the duodenectomized dogs showed a steady loss of weight and strength after operation. At necropsy in these animals an error of technic in one or two points was noted. In some of the animals a dilated common bile duct and marked infection of the entire biliary tract were found. Evidently the transplantation of the ducts did not restore a sufficiently normal condition to prevent infection. In the others the anastomosis of the jejunum to the stomach was not of sufficient calibre to allow the stomach to empty correctly; consequently there were considerable gastric retention and dilatation.

The blood of some of the dogs was examined with regard to cell count, hæmoglobin, carbon dioxid combining power, and hydrogen ion concentration, before and after duodenectomy. No differences were noted which appeared to be owing to the duodenectomy.

In several of the animals the gastrointestinal tract and the passage of a standard barium meal were examined by means of the Röntgen ray. The method consisted of making observations and plates on the course of the standard barium meal two or three times before duodenectomy and at various times after. The barium meal consisted of equal parts of barium sulfate, saturated gum acacia solution, and condensed milk. Fifteen cubic centimetres for each kilogram of body weight of the solution was administered by stomach tube. Observations were made immediately after the administration of the meal and at definite subsequent periods until the meal had passed through the animal.

In general, noteworthy differences were not noted in the passage of the standard barium meal before and after duodenectomy. In most animals the meal started to leave the stomach sooner after duodenectomy than before. This was attributed to the loss of the pyloric sphincter. In a few of the animals the stomach emptied slightly faster after operation than before and in a few others the emptying was delayed. In all cases the changes were slight and did not seem to differ from the slight changes noted by repeated observations on normal dogs. Of course it is possible that if various types of meals had been administered, differences might have been noted. The picture of the gastrointestinal tract always appeared to be normal. A few preliminary observations in the secretory activity of the stomach after duodenectomy were made. No noteworthy change was found.

*The Cat.*—The duodenum is easily removed from the cat, but the operative results are not good. The technic was the same as that used in dogs. Most of the cats recovered from the immediate effects of the operation but did not do well and died within a few days. At necropsy the cause of death usually seemed to be trauma to the pancreas; in no instance could death



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be attributed to loss of the duodenum. One of the cats recovered and appeared normal for 168 days, when it died from an intercurrent disease. From this one complete experiment we can definitely state that duodenectomy is compatible with life and health in the cat (Protocol 3).

*The Hog.*—The hog was selected as an omnivorous type of animal. Duodenectomy is difficult in this species. The bile and pancreatic ducts empty separately. For expedience and in order to remove all the duodenum, it was found best to section the intestine at the duodenojejunal juncture, invert the end of the jejunum, and unite the jejunum slightly more distally to the end of the stomach. The operation was performed on only one hog, and the success and results of the experiment did not seem to warrant further investigation in this species. The animal recovered from the operation.

### DISCUSSION

This brief review of our experiments readily shows that the duodenum is not necessary for life, and the fact that noteworthy changes were not observed makes it appear that its function does not differ greatly from that of the rest of the intestinal tract.

Only one positive finding was obtained in the entire series of experiments. In two of the dogs a large ulcer was found on the jejunal side of the suture line of the gastrojejunal anastomosis. In one of the animals the ulcer perforated, causing peritonitis and death (Dog C, 991, Table I and Fig. 8) 515 days after duodenectomy. The other animal came to necropsy 383 days after duodenectomy and a large ulcer with a hard base was found (Dog C, 919, Table I and Fig. 9).

Eleven duodenectomized dogs were kept under observation for from ten to thirty months. One of these is still alive. Of the ten coming to necropsy, two had ulcers. Since peptic ulcer of the subacute or chronic type is very rare in the dog, this seems significant.<sup>20</sup>

At the suggestion of Dr. C. H. Mayo we are making a more comprehensive study of the effect of duodenectomy in relation to gastric secretion, and are also studying the possible function of Brunner's glands. From these studies we hope to determine the reason for the presence of these ulcers.

### SUMMARY

The investigation was undertaken for the purpose of determining the effect of removing the duodenum. A one-stage operation for removal of the duodenum was developed. The duodenum was removed from the dog, cat, hog, goat, and monkey, although long-continued observations were made only on the dog, cat, and hog. Careful studies on these three species did not reveal any noticeable changes following the duodenectomy. In the dog observations were carried on more than two and one-half years after operation. The animals remained in good condition. No data have been secured to show that the duodenum is of great importance in any of the species studied. However, in two of the ten dogs studied a typical peptic ulcer occurred on the jejunal side of the gastrojejunal anastomosis. Whether

this bears any relation to the loss of the duodenum or any specific part of it, as Brunner's glands, is to be determined.

PROTOCOL 1.—*August 7, 1918, Experiment 552, Dog C 673, an adult female bull terrier, in good condition; weighing 14.3 kg.* Under ether anaesthesia a two-stage operation in one stage was attempted. The pancreatic ducts were traumatized, which necessitated ligation. The duodenum was removed and an end-to-end anastomosis between the jejunum and the stomach made, and the bile drained by a cholecystenterostomy.

The animal recovered from the immediate effects of the operation and remained in fair condition for forty-one days and then died. The cause of death was not determined, but probably it was partially associated with the ligation of the pancreatic ducts.

PROTOCOL 2.—*December 11, 1918, Experiment 892, Dog C 878, a male mongrel shepherd, weighing 20.7 kg.* The duodenum was removed at a single operation. The animal recovered from the operation and remained in excellent condition.

December 31, 1918, the animal was in good condition—its weight was 19 kg.; it remained in good condition. January 8, 1919, its weight was 17.9 kg.; January 14th, 19.9 kg.; January 28th, 19 kg., and February 18th, 19.8 kg. July 3rd the animal was fat, its weight was 21.2 kg.; December 19th, one year after operation, the animal was in good condition—its weight was 18.3 kg.; January 6, 1920, 21.4 kg.; March 4th, 20 kg.; June 4th, 20.2 kg.; July 30th, 19.3 kg. The animal remained in good condition for several months longer and then lost slightly in weight. December 12, 1920, it weighed 16.4 kg., but it soon recovered normal weight. June 30, 1921, two and one-half years after duodenectomy, it was in excellent condition and weighed 20 kg. (Fig. 10).

PROTOCOL 3.—*November 1, 1919, Experiment 747, Cat 173, a male adult in good condition, weighing 2415 gm.* A very fine silk was used for all sutures except for the purse-string suture in transplanting the ducts. Only the pancreatic duct, and the common bile duct, which empty together, were transplanted. The animal recovered from the operation and remained in excellent condition for many weeks.

In March, 1920, it developed distemper. Following this it lost some weight, but remained in fair condition, although it coughed considerably and had a chronic nasal discharge. Pneumonia developed, and the animal died May 7th.

Necropsy was performed shortly after death. Both lungs were markedly involved by the pneumonic process. The site of operation was in good condition. The common bile duct was slightly dilated. Grossly the pancreas was normal. Effect of the operation could not be discerned either grossly or microscopically.

PROTOCOL 4.—*June 10, 1919, Experiment 359, Hog 1, a Duroc-Jersey male, approximately six months old.* The animal was decidedly a runt, weighing only 23.4 kg.; otherwise it was in excellent condition. The technic used in the dog was attempted. The operation was very

## DUODENECTOMY

difficult. The mesentery was too short to allow the direct anastomosis of the end of the jejunum to the pylorus, so that the jejunum was sectioned at its point of origin and the end united to the pylorus by an end-to-end anastomosis. The transplantation of the common bile duct and the pancreatic duct, which are separate in the hog, was accomplished with considerable difficulty.

The animal was quite sick for the first few days, but soon recovered from the immediate effects of the operation. Bile appeared in the urine and the scleras had a slight yellow tinge. The stools showed evidence of lack of bile. After the first week the animal's appetite became normal, bile disappeared from the urine and the stools gradually returned to normal.

May 24, 1919, the animal was practically normal; it weighed 25 kg.

June 20th, the animal was in good condition; it weighed 27.5 kg. It was then sent to the farm where it grew and developed normally. It was kept under daily observation, but no detailed data were recorded. It was fed moderately but never given a full fattening meal.

November 6, 1919, the animal weighed 95.5 kg.

February 26, 1920, the animal weighed 130 kg.

February 27, 1920, the animal was killed, and necropsy performed immediately. The animal was in good condition, moderately fat, but not nearly so fat as it could have been if a heavier feed had been given. The incision was marked by a faint scar. On opening the abdomen a few rather dense adhesions were found at the site of operation; otherwise it was in excellent condition. The biliary tract, however, seemed to be infected and a few small stones ranging from 2 mm. to 4 mm. in diameter were found scattered throughout the liver. The pancreatic duct transplantation had been a partial failure because a portion of the pancreas was infiltrated with fat, although there were large areas of pancreatic tissue interspersed throughout the fat. Grossly and microscopically all other organs were normal. Microscopically the liver showed few pathologic changes and the remaining pancreatic tissue was normal (Figs. 11 and 12).

### POST-OPERATIVE COURSE OF TEN DUODENECTOMIZED DOGS

Animal	Length of life after duodenectomy Days	Cause of death
Dog C 750	325	Etherization.
Dog C 729	327	Obstruction resulting from adhesions around an infected silk suture at the site of the intestinal anastomosis.
Dog C 802	372	Volvulus of large intestine.
Dog C 991	515	Peritonitis following perforation of ulcer at site of intestinal anastomosis.
Dog D 37	490	Etherization.
Dog D 38	556	Results of another experiment.
Dog D 39	555	Results of another experiment.
Dog C 919	393	Results of another experiment.
Dog D 86	480	Etherization.
Dog D 339	555	Etherization.

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## A COMPARATIVE ANALYSIS OF 213 FOREARM AND LEG FRACTURES

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THE following remarks are the result of the study of cases and skiagrams of simple forearm and leg fractures due to accidents of the street, home life and sporting fields. The causes of these accidents were as follows:

Forearm: Back-fires, thirty-seven cases; fall (staircase, on hand), twenty-five cases; fall from horses, five cases; kick by horses, one case; cycling accidents, five cases, foot-ball accidents, four cases; boxing accidents, two cases; cricket accidents, one case; knocked down by vehicles, three cases; unknown, twenty-two cases. Total, 105 cases.

Back-firing of motors appears to be the commonest cause of forearm fractures in this series. The word "fall" includes a variety of mechanisms, such as: "slipping" in the hand, fall from a height, fall downstairs, etc.

The ages of these individuals were distributed as follows:

Between ten and twenty years, forty cases; between twenty and thirty years, thirty-seven cases; between thirty and forty years, fourteen cases; between forty and fifty years, six cases; over fifty years, eight cases. Total, 105 cases.

The distribution of the single *radial* fractures was as follows:

The radius alone was broken in seventy-four cases; the radius and ulna together were broken in sixteen cases; the ulna alone was broken in fifteen cases. Total, 105 cases.

The distribution of the single *radial* fractures was as follows:

Head, five cases; middle third, one case; lower third—upper half, twelve cases; lower half, fifty-six cases. Total, seventy-four cases.

These figures show the lower end of the radius to be the commonest level of fracture (Fig. 1) and the lower half of the lower radial third the point of greatest weakness of the bone to trauma. In fact, the lower radial third was fractured in fifty-four per cent. of the total number of forearm fractures. The transverse line is the commonest direction of the radial fractures, the oblique direction the next common, and the vertical crack the rarest (Fig. 1, Fig. 64). The great majority of these fractures are complete through the bone. The incomplete or greenstick are more common at the upper half of the lower third. The edge of the head was split obliquely in three cases and the neck transversely in two cases. The middle radial third was broken across in a single case, as the result of a boxing punch.

The distribution of the single *ulnar* fractures was as follows:

Upper third (olecranon), six cases; upper third (coronoid), two cases; upper third (below coronoid), two cases; middle third, two cases; lower third, three cases. Total, fifteen cases.



These facts demonstrate the upper ulnar end to be the commonest seat of fracture (Fig. 2) and the olecranon the part of the ulna most frequently injured. In three cases the olecranon fracture was incomplete. In one case of complete fracture of the base of the olecranon there was comminution and separation of the fragments. In two cases of through fracture of the

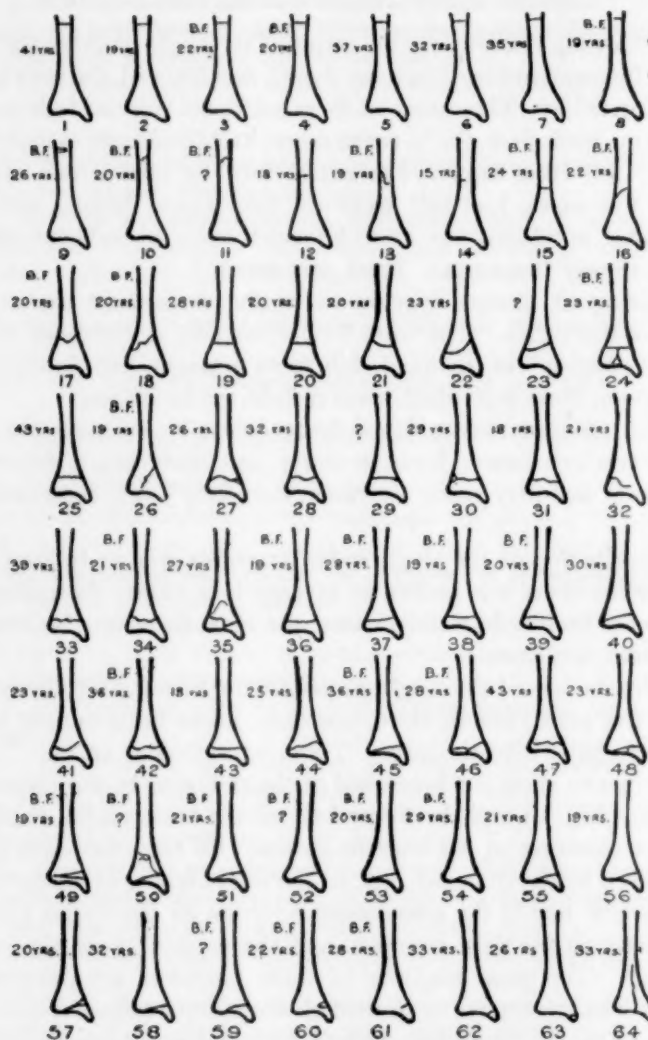


FIG. 1.—(a and b) Shows sixty-four single fractures of the lower third of the radius. Those marked B.F.—30 all are due to back-fire. The ages of the cases are indicated as well.

apex and base of the olecranon there was no diastasis of the fragments. In two cases of fall on the hand, the coronoid was broken at its beak.

If the two last tables are compared it is obvious that the lower radial and the upper ulnar ends are the two most vulnerable seats of these bones



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to trauma. In fact, the olecranon was fractured in forty per cent. of the single ulnar fractures, and the lower half of the radial lower third in seventy-seven per cent. of the radial single fractures.

The tip of the ulna styloid process appeared broken in thirteen per cent. of single fractures of the ulna, and the radial styloid in five per cent. of single radial fractures. These were cases of so-called "sprained wrists." It must be remembered that the "os triquetrum secundarium," and the "intermedium antebrachii," which sometimes appear in skiagrams of the wrist, may be taken for a fracture. The "os radiale externum" occupies a much lower position in relation to the radial styloid, as I have shown in other articles.

In one case the lower ulnar end was fractured in a spiral fashion.

The distribution of the combined *radial* and *ulnar* fractures was as follows: Radius: Upper third, three cases; middle third, two cases; upper half, five cases; lower half, six cases. Ulna: Upper third, four cases; middle third, one case; upper half, two cases; lower half, nine cases. Total, sixteen cases.

These figures show the lower radial and ulnar third to be the commonest seat of fracture. The olecranon and the radial head were not broken in any of these cases, but the external lip of the coronoid appeared fractured in a backfire case (Fig. 3, Fig. 1).

The relative level of the line of fracture, taking the level of the radial fracture as the basis for comparison, was as follows: Ulnar fracture below the radial, seven cases; ulnar fracture above the radial, three cases; ulna fracture level with the radial, six cases. Total, sixteen cases.

The distance between the two levels appears to be greater when the ulna is broken above the radius, the widest distance being in a case of backfire, when the radius was broken at the lower third and the ulna was fractured at the coronoid brim (Fig. 3, Fig. 1). In one case the fractures of the ulna and radius were comminuted.

If the radial and ulna single fractures and the radial and ulna combined fractures are analyzed, it will be found that the lower radial end and the upper ulnar end are the most commonly involved parts of these bones. The middle third of the radius and ulna was fractured in three per cent. of the total number of forearm fractures. The fracture of the ulnar middle third was accompanied by luxation forwards of the radial head which appears to be the rule in these cases. In the fractures of both ulna and radius the former is usually broken below or at the same level of the radial fracture.

*Relationship between the injury and the kinetoplastic effect on the bone:* Backfires or chauffeur's fracture (Figs. 1 and 3). This forms a very important group of forearm fractures. There were thirty-seven authentic cases distributed as follows: Radius and ulna, six cases (Diag. 3, Figs. 1 to 6); ulna alone, no cases; radius alone, upper third, one case (Diag. 3, Fig. 7); radius alone, middle third, no cases; radius alone, lower third, upper third, six cases (Diag. 1, Figs. 3, 4, and 8 to 11); lower third, middle third, four cases (Diag. 1, Figs. 13 and 15 to 17); lower third, lower third, twenty cases

(Fig. 1, Figs. 18, 24, 26, 34, 36 to 39, 42, 45, 46, 49 to 54, and 59 to 61). Total, thirty-seven cases.

These interesting figures show the lower radial end to be the most frequent seat of "chauffeur's fracture" (Fig. 1, all figures marked B. F.). The neighborhood of the epiphyso-diaphyseal line is, on the other hand, the most common level of the fracture, as it was broken in fifty-four per cent of back-fire cases. The upper part of the radial lower third is often fractured incompletely; in fact, two cases out of six were of the greenstick variety. The age of the case bears no relation to the level of the fracture.

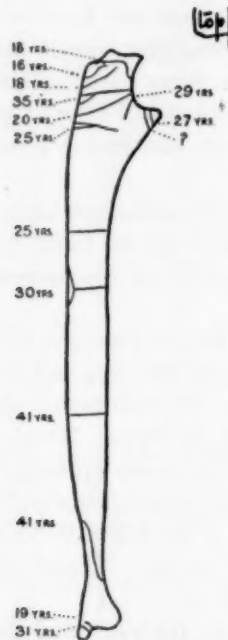


FIG. 2.—Shows fifteen single fractures of the ulna.

The common direction of the radial fracture is usually transverse or slightly oblique from within outwards. The radial styloid process was fractured in one case only. The inner lip of the radial head was fractured in another case (Fig. 3, Fig. 7) and clinically there was some local pain while rotating the radius. The edge of the outer side of the coronoid brim was broken in another case (Fig. 3, Fig. 1,) but this fracture was accompanied by fracture of the radius at the junction of its middle and lower thirds. The two last-mentioned fractures appear to depend on the degree of flexion of the elbow and the time at which the hand is struck by the handle of the motor. It is necessary to think of the multiple angles the wrist, forearm and arm form between themselves in imparting rotatory movements to the motor, to understand the side which will give way. It appears that the radial head fracture depends on the degree of forearm flexion at the elbow, and the side

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of the capitellum split on the degree of forearm pronation. The ulna coronoid fracture, on the contrary, depends on the degree of forearm extension at the elbow, and the extent of arm abduction.

The two forearm bones were fractured in sixteen per cent. of back-fire cases (Fig. 3, Figs. 1 to 6). In two cases the ulna was fractured in a spiral fashion. In five cases the lower radial and ulnar thirds were fractured, as shown in the Fig. 3, and in one case only the coronoid brim was split as already mentioned. The upper two-thirds of the radius and ulna were, in this series, free from injury due to back-firing, with the exception of the edges of the coronoid and radial head. The carpal and humeral injuries that I have met with, due to back-firing, are not mentioned in this paper.

I have tried to find out whether the cases kept the pollex under or above the handle while starting the motor, or if the handle was grasped from above. It appears that the former position is a safeguard, although a few cases have met with the fracture in spite of that precaution. The grasping of the handle from above is not well known by these individuals. I could not, on the other

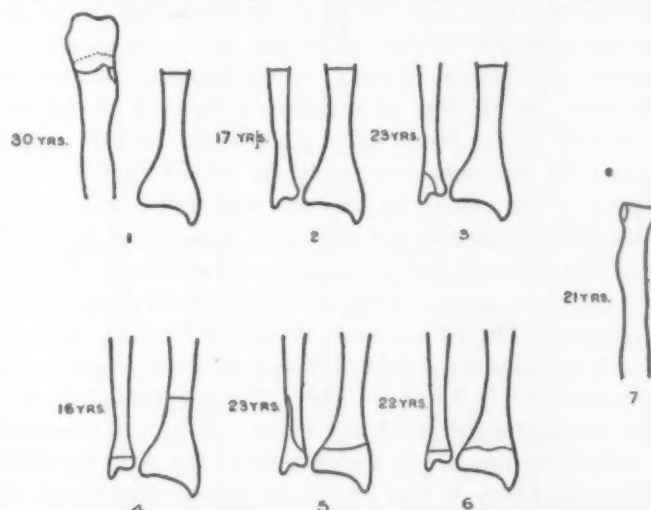


FIG. 3.—Shows some back-fire fractures. Figures 1 to 6 being fractures of both forearm bones, and figure 7 a single fracture of the radial head. Note figure 1 a fracture at the junction of the middle and lower radial third and outer brim of the coronoid process of the ulna.

hand, come to a definite conclusion regarding the type of engine which more commonly originates these fractures. Want of experience on the part of the drivers can hardly be adduced, as the majority were men long used to driving. There was no case of recurrence among these fractures.

It is difficult to explain why some of these cases should have one or the two forearm bones fractured. The reason appears to be the position and amount of wrist abduction at the time of the back-firing.

Lavermicocca suggested that these chauffeur fractures were due to an effort of "taglio." Some of the back-fire fractures mentioned in this article have not yet been described in the literature (Sir G. Beatson, Caccia, Faur, Ghillini, Lucas-Championniere, Lund, Maximovich . . .).

The so-called *epiphysial strain* and the fractures of the radial lower end form an interesting clinical subject. In this series, there were six cases of epiphysial separation, as follows: four cases were due to back-fires and two to fall on the hand. The ages of the former were: Two of nineteen years, one twenty-two years; one thirty-six years (Fig. 1, Figs. 36, 38, 42 and 60); of the latter fourteen and fifteen years. In four cases there was complete separation of the fragments, and in two there was only widening of the radial epiphysis at its outer end for one-fourth and half of its width. The swelling is diffuse and there is an ecchymosis at the front or back of the wrist, whereas in the cases of so-called sprain there is no ecchymosis and the pain is not localized and appears to shoot along the back of the forearm towards the elbow. On pressing the bone the pain is referred to a diffuse area and is not localized to the styloid line as in fracture. I was not able to find the small, localized area of swelling Speed refers to in his paper.

There were four cases of *reversed Colles* or *Goyrand fracture*. Two cases of nineteen and twenty-eight years of age were due to back-fire. There was a case of fourteen years who fell on the hand, and the last of forty-three years of age met with this fracture by falling on the hand with the fingers and wrist flexed. The physio-pathology of the Goyrand fracture is a matter of some difficulty. In the case of chauffeur's fracture of this type, either there is a direct hit, or the injury takes place while the hand and wrist are dragged upwards by the sudden upper stroke of the handle.

If the causes of the other fractures are analyzed it will be found that an apparent similar trauma does not produce a regular and systematic identical type of fracture. For instance, the terms fall on the hand, torsion of the forearm, etc., include a great variety of forces which render such classification very obscure. The compression theory of Stevens, referring to the lower radial end, explains the physio-pathology of these fractures, which are, after all, the commonest in the upper limb. The hyperextension of the wrist is one of the primary reflexes of the limbs. It is well displayed in the mammalian series, and constitutes the attitude of the wrist assumed by men in a fall. Experimentally, it has long been proved that dorsal flexion, or the rarer palmar flexion, are followed by fracture of the radius at its lower end (Brossard, Cotton, Hamilton, Pilcher). This fact fits in with the theory.

The *olecranon fractures* (Fig. 2) result either from direct trauma: striking the elbow against an object, impact of a falling body on the elbow, etc.; or, of a fall combined with some sudden and violent forearm flexion. It is difficult to find out why some of these cases show complete separation, while others are only completely or incompletely broken without exhibiting any marked anatomical deformity. It seems that the intensity of the injury, and the degree of development of the triceps and tricipital fascia, are the anatomical factors which explain these varieties of clinical conditions. The *fractures of the coronoid* occurred in men beyond twenty-four years of age, and were due to falls on the hand in a motor collision and in a bicycle accident. In neither was there any evidence of direct trauma. The five radial

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head and neck fractures occurred in cases nineteen, twenty-one, twenty-three, thirty and thirty-one years of age, and were due to a fall on the hand from a height, back-fire (Fig. 3, Fig. 7), thrown off top of bus and fall on the open

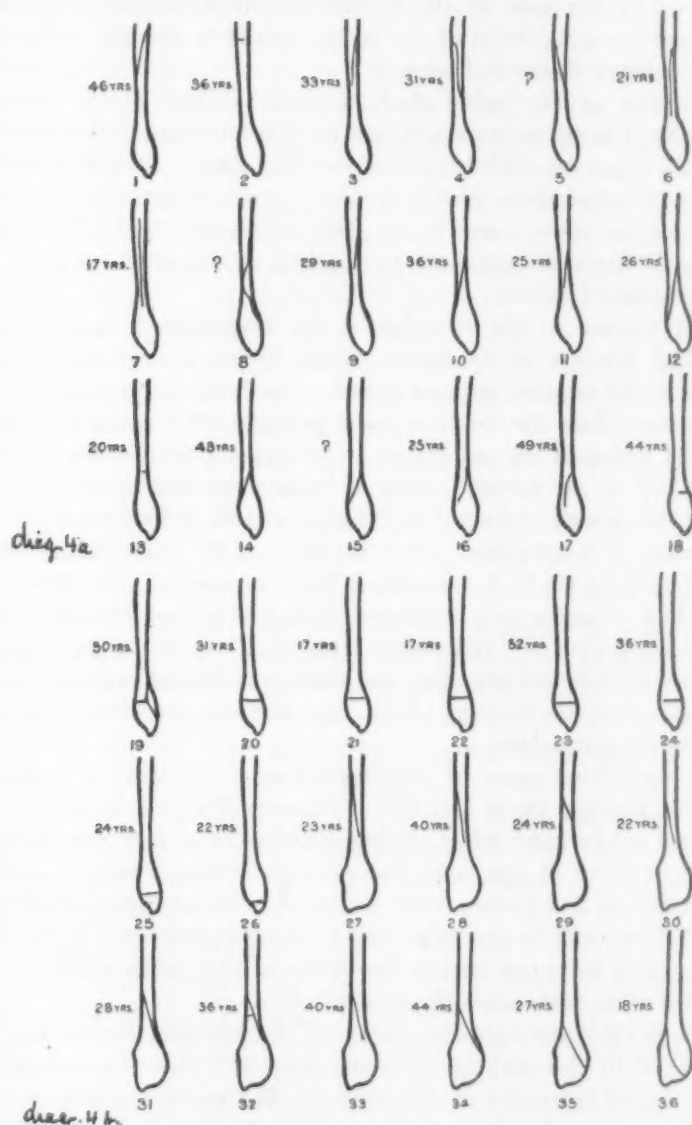


FIG. 4.—(a and b) Shows thirty-six single fractures of the fibular lower third. Figures 1 to 26 are antero-posterior, and figures 27 to 36 lateral views of the bone. Figure 7 is a good example of a medullary split. Figures 26 to 36 show the direction of the fracture to run downward and forward.

hand, cycle accident, and a fall from a height. These fractures are confined to the area of the bone above the bicipital tuberosity, and it is interesting to note that the line of the crack is almost always longitudinal, which appears to show that it is due to the impact of the bone against the humeral capitellum.



*The single forearm fractures* due to indirect trauma are better understood if the two bones are considered as a single structure. This fact, roughly speaking, appears in some mammals as a feature of their skeletons (horses, deer . . .). In the case of the human fractures, the upper segment of the ulna and the distal third of the radius should be thought of as the ends of these combined theoretical bone.

The middle of the radial shaft, and the middle of the ulnar shaft were fractured in three cases and due to direct trauma. Fracture of both bones at the upper two-thirds occurred in four cases. It will be interesting to find out whether these double fractures occur simultaneously, or if one bone follows the other, much in the same way as the radial head slips forward over the humeral capitellum, having lost, as it were, the support following the mid-ulnar fracture.

With reference to the direction of the fragments it appears that the subperiosteal fracture of the radius usually shows an angulation forwards. The upper radial segment appears to have a tendency to point inwards. The ulnar fractures show the lower segment pointing more commonly outwards. In fact, the action of the supinators at the upper half and the pronators at the lower half of the forearm, seem to explain the direction of these deviations, and this is well explained in Whipple and St. John's paper.

In a case of longitudinal spiral fracture of the lower ulnar end there was a fracture of the fifth metacarpal base; in another case the tip of the radial styloid fracture was associated with fracture of the scaphoid neck. This was not a case of "naviculare bipartium," since the gap between the fragments was wide and irregular, and there was clinical evidence of trauma. In one case a complete fracture of the olecranon was associated with fracture of the humeral epitrochlea.

There were four cases of *longitudinal or "medullary" cracks of the radius* (Fig. 1, Figs. 35, 50 and 64) as follows: Man, thirty-three years old, who twisted the forearm while playing foot-ball; two men twenty-three and twenty-seven years of age, who fractured the radius starting a motor-car; in the fourth age and history were unknown. These splits appeared at the lower radial end and in two cases had a very irregular distribution. These medullary splits were not seen in the shafts of the radius or ulna. Parrish and Bendell cases were similarly distributed.

It is noticeable the apparent rarity of the so-called Colles' fracture, so well described by this surgeon as taking place at "about an inch and a half above the carpal extremity of the radius." In these series there were three cases that presented the classic features of this fracture and in one the impaction required forcible wrenching before the reduction of the fragments was obtained.

There were not in this series any cases of *marginal fractures* of the radius (Rhea-Barton and Letenneur type). The posterior edge of the lower radial diaphyseal end was broken in a wedge shape in a boy eighteen years old, who fell on the hand, having been thrown off a horse. The ulnar and radial



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epiphyses were wider than usual, and there was at the anterior fourth of the radial diaphyseal end, a short vertical split for five millimetres. In the case of another patient fifteen years old, who fell on the hand, there was some widening of the epiphysis, and a short vertical split at the end of the diaphysis of both radius and ulna. These diaphyseal splits are apparently due to the compression force of the injury. In another case of a boy fifteen years old, and who fell from a horse on the hand the epiphysal line of radius and ulna appeared wider than usual in the skiagram, and clinically the case resembled a real case of epiphysal diastasis. The clinical differentiation between the so-called "separation of the epiphysis," widening of the epiphysal line and epiphysal strain, is an important matter from the prognostic standpoint.

Leg—Causes of Fracture: Slipped, twisted, sprained ankle, twenty-five cases; fall, twenty-one cases; fall from horses, four cases; cycling accidents, nine cases; foot-ball accidents, seven cases; cricket accidents, one case; tobogganning accidents, one case; knocked down by vehicles, eight cases; kicked by horses, eight cases; fall off wall, and barrel on leg, two cases; unknown, thirty-two cases. Total, 118 cases.

Slipping on the foot, slipping and twisting the foot are common occurrences among these cases.

The ages of these cases were distributed as follows: Between ten and twenty years, nineteen cases; between twenty and thirty years, thirty-six cases; between thirty and forty years, twenty-seven cases; between forty and fifty years, eighteen cases; between fifty and sixty years, nine cases; between eighty and ninety years, one case; unknown, eight cases. Total, 118 cases.

The distribution and sites of the fractures were as follows: The fibula and tibia together were broken in fifty-two cases; the fibula alone was broken in forty-two cases; the tibia alone was broken in twenty-one cases; the fibula and tibia together were broken in several places in four cases. Total, 119 cases.

Fracture of both legs occurred in one case. The combined tibia and fibular fractures are the commonest, as they occur in forty-seven per cent. of the total number of cases. The fibula is the next common, as it was fractured in thirty-eight per cent.

The distribution of the single *fibular* fractures was as follows: Upper third, one case; middle third, four cases; lower third, upper third, three cases; lower two-thirds, thirty-four cases. Total, forty-two cases.

The lower two thirds of the fibular lower third are the most vulnerable part of the bone to trauma (eighty per cent.) (Fig. 4). The commonest direction of the fracture is oblique from before backwards and upwards. Although the transverse split is commoner at the very lower end of the bone. The former type of injury is very commonly only seen by means of the lateral skiagram (Fig. 4, Figs. 27 to 36), and often missed clinically. In fact, these oblique cracks are a good skiagraphic picture of some clinical types of "sprained ankle."

The longitudinal splits at the centre of the diaphysis are very common in the fibula. In fact, these longitudinal or medullary splits appear at any level,

with a marked prevalence, however, for the middle third of the bone. I suggest the name "medullary" as these cracks run along the medullary clear space of the bone.

Thirty-eight per cent. of the fibular malleolar fractures were of the incomplete variety.

The distribution of the single fractures of the *tibia* was as follows: Upper third, outer tuberosity, two cases; upper third, tibial tubercle, two cases; middle third, two cases; lower third, upper third, eight cases; lower third (malleolar), seven cases. Total, twenty-one cases (Fig. 5). The lower

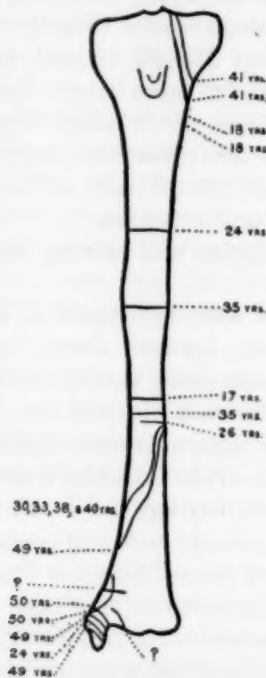


FIG. 5.—Shows twenty-one single fractures of the tibia. Those corresponding to the age of eighteen are fracture-separation of the tibial tubercle.

tibial third is the commonest level of fracture. The upper third part of the lower third showed eight fractures, of which four were of the spiral type. This fact forms a peculiar feature of the tibia from the traumatologic standpoint. The malleolar region was fractured as shown in Fig. 6. The distribution of the fractures at the upper tibial third is rather interesting. The outer tuberosity was vertically split in two cases of men both forty-one years old. The tibial tubercle was partially detached in two cases eighteen years old.

The distribution of fractures of the *fibula* and *tibia* together was as follows: Fibula—upper third: *upper half*, three cases; *lower half*, seventeen cases; middle third, ten cases; lower third—*upper half*, twelve cases; *lower half*, ten cases. Tibia—upper third: *upper half*, one case; *lower half*, one case; middle third, four cases; lower third—*upper half*, thirty-three cases;

*lower half*, thirteen cases. Total, fifty-two cases. The lower tibial third was fractured in eighty-eight per cent. of these double cases. The upper half of the lower tibial third appears to be the most fragile part of the bone, and of the thirty-three cases sixteen were of the spiral type. The spire usually ran from within outwards and upwards, in varying lengths, and rarely more or less vertically and in a large area of the bone. In one case it extended along the complete lower third and part of the middle third. In seventeen cases the fracture was seen transversely across the bone. In three cases the tibial malleolus was completely broken across. In one case of a man forty-four years old, and who twisted his foot in a railway collision, the tibial malleolus was fractured subperiosteally and the line of the crack extended in a V-like fashion along the lower third of the shaft (Fig. 6, Fig. 6). It appears that the tibial lower third behaves in these fractures almost identically as when fractured by itself. The anterior edge of the lower articular end of the tibia was broken in two cases (Fig. 6, Figs. 13 and 14), and the posterior edge in two cases as well (Fig. 6, Fig. 12). These marginal fractures appear to have occurred at the centre part of the articular brim, and near the fibular side. The middle third of the tibia was fractured in four cases, and in one case the fracture was of the spiral type. The upper tibial third was split transversely in two cases. This fact was not seen when the tibia was fractured alone.

The fibular upper and lower thirds are the two commonest seats of fracture. The former was broken in thirty-eight per cent. and the latter in forty-two per cent. of these double cases. This shows a slight discrepancy, compared with fractures of the fibula alone. Very often the split is of the medullary type.

The relative level of the line of fracture, taking the level of the tibial fracture as the basis of comparison, was as follows: Fibular fracture below the tibial fracture, four cases; fibular fracture above the tibial fracture, thirty-four cases; fibular fracture level with tibial fracture, fourteen cases. Total, fifty-two cases. In sixty-five per cent. of these cases the fibula was broken above the tibial level of fracture. The widest distances between the two fractures being: (a) Transverse fracture at the junction of the middle and lower tibial thirds, and the tip of the fibular head due to a fall on the foot; (b) incomplete fracture of the tibial malleolus and medullary split of six centimetres along the middle third of the fibula, in a girl who fell and twisted the leg (Fig. 6, Fig. 10, etc.).

The spiral fractures of the tibial lower third were accompanied by fracture of the lower part of the fibular upper third in twelve cases out of sixteen. In two cases of these spiral fractures of the tibia, the fibular fracture accompanying it was at the middle third of the bone. In one case the fibular fracture was at the middle of its upper third, and in another the fibula was fractured four centimetres above its lower tip. These fibular cracks were transversely seen across the bone and in some cases they ran obliquely

on the shaft. In one case the fibular split was of the longitudinal medullary type.

Ten out of fourteen cases of fibular and tibial fracture at the same level were at the junction of the middle and lower thirds of the tibia.

The fibula was fractured below the level of the tibial fracture in seven and six-tenths per cent. of cases.

These important facts show that the *great majority of the tibial lower end fractures are accompanied by fibular injury*. Some of these fibular fractures

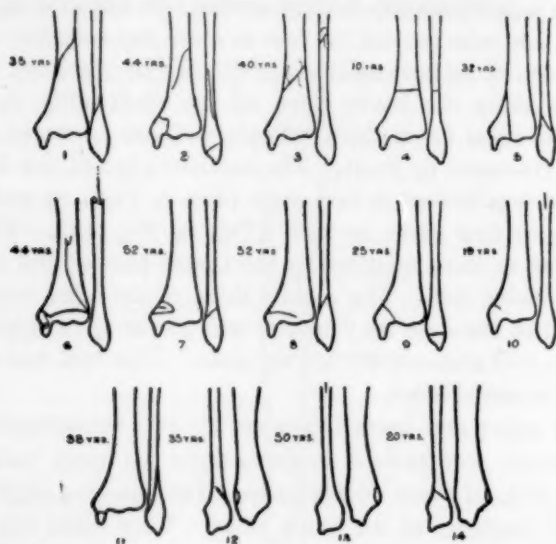


FIG. 6.—Shows fourteen fractures of the tibia and fibula lower thirds. Figures 6, 10 and 13 show the medullary split to run along to the middle third of the fibula. Figures 1 to 11 are antero-posterior and figures 12 to 14 lateral views of the bones. These last three figures, illustrate the marginal type of tibial fracture.

can only be diagnosed with certainty by means of the X-rays, since the medullary splits are of comparative frequency. Doctor Marsh avoids missing these combined injuries by taking in one plate the proximal, and in another the opposite view of the distal end of the bones. The chances of these cases passing unnoticed are then negligible, without increasing the cost of running the radiologic department.

In four cases the tibia and fibula were fractured in more than one place. The distribution of the lines of fracture was very irregular, and, to summarize, the tibia showed altogether eight cracks and the fibula seven in these combined four cases.

If the whole series of the tibial and fibular fractures are analyzed it will be seen that the fracture of both bones is the rule, and the single tibial and fibular fractures the exception. The malleolar region is the commonest seat of the single fractures, particularly in the case of the fibula. The upper half of the tibial lower third fracture is practically always accompanied by fracture of the fibula somewhere above its middle, sometimes at the same level, and very rarely below the tibial line of fracture.

The fibular malleolus was completely broken in fifteen per cent. and incompletely in twelve per cent. of the total leg fractures. The tibial malleolus was completely fractured in three per cent. and incompletely in two per cent. of these fractures (Fig. 6). In two per cent. of these cases a complete fracture of the fibular malleolus was associated with incomplete fracture of the tibia.

These figures demonstrate the *comparative rarity of Pott's and Dupuytren's fractures*, as conceived by these illustrious surgeons. Pott's fracture is, however, commoner than Dupuytren's. The figures generally given relating to the last-named fracture (Malgaigne, Tanton, Potherat . . .), appear to be too high accurately to represent the percentage under modern conditions of civilization.

*Relationship between the injury and the kinetoplastic effect on the bone:* Slipping on the foot appears to be the commonest type of mechanism and history given by these cases. This usually gives rise to a fracture of the malleoli. The twisting of the leg is particularly responsible for the spiral variety of fracture. The types of malleolar fracture and fracture dislocation due to falling, slipping and twisting the ankle are very numerous.

*Marginal fractures of the tibia:* There were four cases. *Anterior marginal:* (a) Man, fifty years of age, run over by a motor car; medullary split of the middle third of the fibula, and small wedge broken off from anterior edge of the lower articular end of tibia (Fig. 6, Fig. 13); (b) boy, twenty years old, thrown from horse and fell on heel; complete transverse fracture of external malleolus and anterior marginal fracture of tibia, as above (Fig. 6, Fig. 14). *Posterior marginal:* (c) man, thirty-five years, kicked by a horse; incomplete, oblique fracture of the fibular malleolus and of the posterior lip of the tibial lower articular margin (Fig. 6, Fig. 12); (d) boy, eighteen years of age, fall from bus on to toes, and fracture of posterior lip of tibial lower margin only.

The marginal fractures of the tibia are oftener accompanied by external malleolar fracture as shown above. The tibial split appears to take place somewhere at the centre of the tibial articular border, but is very difficult to locate exactly, on account of indistinctness in the anteroposterior skiagram. A fall on the hyperextended or hyperflexed foot appears to explain these rarer fractures. Earle, in 1828, described the first case ever reported; the patient was "knocked down by two men . . . as he fell his right leg went under him and his ankle struck against the curbstone." The man was fifty-three years of age and the fracture was at the posterior edge of the articular tibial margin. The surgical importance of these fractures is brought out in the works of: Cotton, Sir R. Jones, Malgaigne, Meissner, Quénu, Pels-Leusden, etc., in a masterly fashion. The frequency of these fractures appears to be higher than the last writer has suggested, and the anterior group forms the reason why the foot must be kept well flexed at the ankle in the treatment of these cases, as pointed out by Sir R. Jones.



The so-called *longitudinal or medullary splits* occurred as follows: *Fibula only*: (a) Boy, seventeen years of age, sprained ankle, medullary split of seven centimetres at the lower third of fibula (Fig. 4, Fig. 7); (b) boy, eighteen years of age, fall on foot, medullary split of five centimetres at the junction of the middle and lower thirds of the fibula; (c) man, twenty-seven years of age, cracked the middle of fibula for seven centimetres while stopping a runaway horse and fell on side of leg; (d) man, forty-six years of age, fell on the floor and fractured incompletely the fibular malleolus, accompanied by longitudinal split of middle of same fibula in thirteen centimetres extension. *Tibia and fibula fractures*: (a) Boy, nineteen years of age, fall on leg, incomplete fracture of the tibial malleolus, and five centimetre medullary split at the middle of the fibula (Fig. 6, Fig. 19); (b) man, twenty-nine years of age, fell off a bicycle, oblique fracture at the junction of the middle and lower thirds of tibia, and five centimetre medullary split at the junction of the upper and middle thirds of the fibula; (c) man, forty-four years of age, twisted ankle in a railway accident, comminuted fracture of tibial malleolus and transverse longitudinal split at lower tibial third for seven centimetres, accompanied by comminuted fracture of fibula lower third and longitudinal split for three centimetres at the junction of the middle and lower thirds of the fibula (Fig. 6, Fig. 6). *Tibia only*: (a) Man, fifty years of age, twisted ankle and split of tibial malleolus in a longitudinal direction for four centimetres (Fig. 5). It is difficult to find out the cause of these special fractures. It appears, however, that an indirect type of violence and a probable twist of the limb are responsible for these longitudinal splits. In fact, these cracks can be obtained in a greenstick by means of flexion, rotation and compression produced by the two hands holding the cut ends. Malgaigne described these cracks in the humerus and Cloquet in the femur. I have been able to find evidence of these splits or cracks in those bones, and in several occasions, and due to direct action of bullets. In the case of the forearm and leg bones referred to above, the mechanism of the production of these splits seems to vary, as I have already ventured to point out. I have not been able to find any marked ecchymosis in these cases, which seems to indicate that the fracture is subperiosteal in some cases. The main clinical feature of these cases is the pain and tenderness diffused along the fibular line, and easily elicited by gentle finger tapping.

*Single fractures of the middle third of the tibia and fibula* appear to be due to *direct injury*—run over, fall against an object, fall of heavy masses on the limb, kicks. In some cases the lines of fracture may be multiple; for instance: Man, thirty-seven years of age, kicked by horse on the leg, fracture of fibula at upper and lower parts of middle third, and comminuted fracture of upper end of lower third of tibia, etc. *The multiplicity of the points of fracture can be due to indirect and direct injury combined*, as shown by the following case: Man, forty-four years of age, twisted foot and fell on the leg; there was a fracture of the upper end of the outer malleolus and



## ANALYSIS OF 213 FOREARM AND LEG FRACTURES

upper part of lower third of fibula, and fracture of the tibial malleolus and outer side of the upper part of the lower tibial third.

A fall on the foot followed by adduction or abduction at the knee appears to be the cause of the *tibial tuberosity fracture*. There were two single cases of outer tuberosity fracture in this series. Both patients were forty-one years old.

*The tibial tubercle* was detached in two cases. Both were eighteen years of age. In one there was separation of the lower vertical part of the tubercle, in the other there was a wide separation of the vertical part of the tubercle and beginning of the horizontal plate of the epiphysis. The latter was due to a fall on the foot while playing foot-ball, and a likely type of accident which might have produced a fracture of the patella in an older case.

The cases of *fracture of both tibia and fibula* are explained by the intensity of the injury, mechanism of the trauma, and fragility of the bones. It is not possible to systematize all these cases by means of the nature of the trauma. *The spiral type of fractures* of the leg appear to be rather common and seem to represent the rotation element of the trauma. If the rotation is accompanied by compression, as I have ventured to suggest, the bone will break in a longitudinal direction. This was exemplified by the medullary splits as shown above.

An inversion or eversion of the foot appears to explain the malleolar injuries and their wonderful varieties. The foot, as Sir Robert Jones has said, may be dislocated out and the fibular malleolus may not be broken. The injury then may be only localized either at the tibial malleolar tip, stretching or rupture of the internal ligament of the ankle-joint, or even evidence of the inner malleolar contusion may be wanting.

The so-called *epiphysial and juxta-epiphysial strain* is not an uncommon occurrence at the ankle. The X-ray examination may then show no evidence of injury and yet clinically the case resembles a malleolar fracture. There may be swelling and a slight ecchymotic tint at the malleolar and upper calcaneal regions. The pain elicited by means of gentle finger pressure, appears to be more diffuse, extends in a wider area, has not a definite localization to the malleolar ends, and seems to shoot indefinitely upwards towards the knee should the patient attempt to move the limb. At first the functional disability is as notable as in a real fracture and the case may come under the title of local shock. The differential diagnosis, however, of some malleolar fractures (without talar luxation), and the so-called sprained ankle or contused leg, forms still in cases where radiography is not obtainable, an interesting field for observation and reasoning, so well shown in the classic works of Pott, Dupuytren, Cooper and Malgaigne.

In one case of a man thirty-six years of age who fell from a height, there was a fracture of the fibular malleolar tip on the left, and a fracture at the same level of the fibular and tibial lower thirds of the right leg. There was not in this series any case of fracture of the external angle of the tibia.

CONCLUSIONS

1. Back-fire is one of the commonest causes of forearm fracture (thirty-six per cent.) and slipping and twisting the ankle the commonest mechanism of leg fracture in these series.

2. Fracture of the radius alone is the commonest in the forearm (seventy per cent.) and fractures of both tibia and fibula the commonest in the leg (forty-four per cent.).

3. The radius was fractured in eighty-four per cent. of cases of forearm single and double fractures, and the fibula was fractured in seventy-nine per cent. of cases of leg single and double fractures.

4. The lower third of the radius is the most fragile part of the bone and was fractured in ninety-one per cent. of single radial fractures, and the lower third of the fibula is the weakest point of the bone and was fractured in eighty-eight per cent. of single fibular fractures.

5. The upper third of the ulna is the commonest seat of single ulnar fractures (sixty-six per cent.), and the lower third of the tibia the commonest place of single tibial fractures (seventy-one per cent.).

6. The lower third of the radius and ulna is the commonest seat of double forearm fractures (seventy-two per cent.), and the lower tibial third the commonest level of the leg double fractures (eighty-eight per cent.).

7. The lower third, the lower half of the upper third, and the middle third of the fibula is the order of frequency of this bone fractures when accompanied by tibial fracture.

8. The ulna is usually fractured below the radial level of fracture (forty-three per cent.), and the fibula above the tibial (sixty-four per cent.).

9. The classic fractures of Colles, Pott, and Dupuytren, as conceived by these authorities, are comparatively rare.

10. Epiphysial strain, widening of the epiphysial line and the epiphysial fractures are commoner at the wrist.

11. The marginal fractures of the radius (Barton, Letenneur) are rarer than the marginal tibial fractures.

12. Longitudinal or medullary splits are commonest in the fibula.

13. Chauffeur's fracture may occur at the upper end as well as at the lower end of both radius and ulna.

14. The commonest direction of the fibular fractures is from before backwards and upwards and usually incomplete, and only seen in the lateral skiagram.

15. Fractures of the tibial tubercle appear to occur in a growing bone, and fractures of the tibial tuberosity in an adult bone.

16. Fractures of the upper half of the ulna, radius, tibia and fibula diaphysis are usually due to direct trauma.

My thanks are due to Col. Tilbury Brown, C.M.G., D.S.O., and Capt. A. Marsh, officer in charge and radiologist, for permission and assistance in using the skiagrams.

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## DISLOCATION OF THE PISIFORM

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**CASE REPORT.**—On March 31, 1921, W. G., a school boy eleven years old, came to the Mount Sinai Hospital Dispensary stating that the previous day, while playing, he had fallen and struck his left hand. His exact position at the time of the fall he did not remember. After the fall he had moderate pain in the left wrist but received no treatment. During the night the wrist became swollen and more painful.

When examined he seemed to have a fracture of the lower end of the radius with little displacement, the swelling preventing a more accurate diagnosis. An anterior padded splint was applied and an X-ray examination requested.

As shown by the print, there was a backward displacement of the lower epiphysis of the radius and a dislocation forward and somewhat upward of the pisiform. With the X-ray diagnosis in mind, reexamination showed the pisiform at a higher level than normal and distinctly movable. It could be pushed up or down through a distance of half an inch; lateral mobility was less marked. Without anaesthesia an attempt was made to reduce the epiphysis. In order to overcome the displacement of the pisiform a small gauze pad was strapped with adhesive plaster over this bone pulling distally, and the wrist put up in flexion.

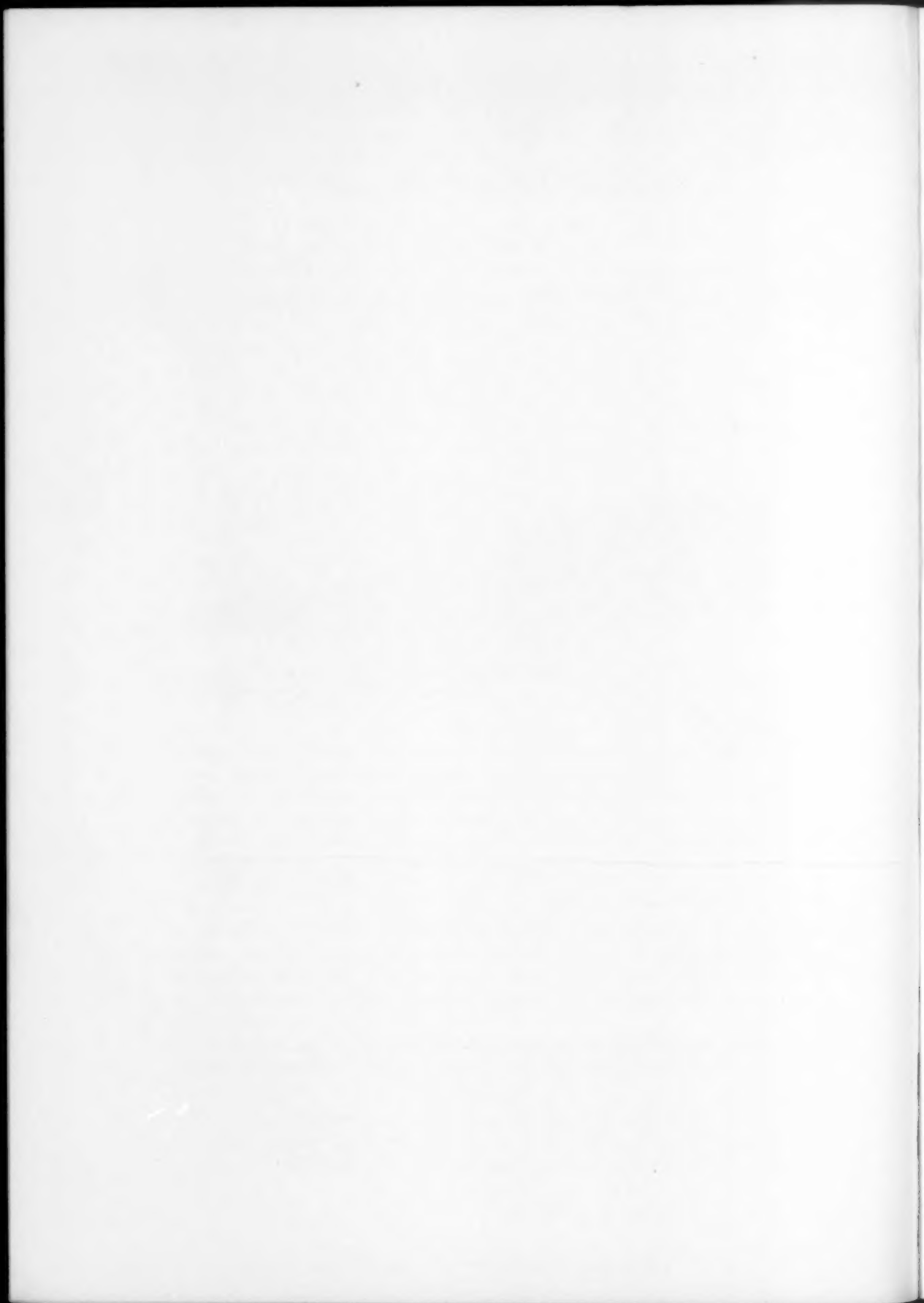
A second X-ray examination showed the epiphysis only partially reduced and the pisiform seemingly in place; but the angle at which the exposure was made was not the same as in the original, so of this fact we could not be certain. Ten days later passive motion was begun. At this time the pisiform though still more movable than normal was distinctly less so than on the previous examination. About the fifteenth day all function was returning rapidly. The patient was referred for another X-ray examination but failed to report and did not again appear at the dispensary.

In 1901 Eigenbrodt<sup>1</sup> collected five cases of dislocation of the pisiform. I have been able to find one additional case previous to 1901 and three instances since that time. Of this total of nine cases the report by Bieberbach<sup>2</sup> was not available. The five instances mentioned by Eigenbrodt antedate the use of the Röntgen ray.

Erichsen<sup>3</sup> and Ferguson<sup>4</sup> give no details other than that the injury was caused by muscular violence. Barois'<sup>5</sup> patient was a soldier who had had the lesion for many years; the pisiform was freely movable, otherwise he suffered no inconvenience. The cause in the case reported by Gras<sup>6</sup> was muscular exertion applied in a position of extension and adduction of the wrist. The pisiform was reduced and held by a bandage. The patient



FIG. 1.—Separation of lower epiphysis of radius, and dislocation of pisiform bone.





## DISLOCATION OF THE PISIFORM

removed the bandage after three days but the bone remained in place. Van der Donck's <sup>7</sup> patient fell on the dorsum of the hand with the wrist in flexion. The X-ray plate showed the pisiform between the radius, semilunar and cuneiform, lying in the joint. The bone was excised with marked improvement of the disability. In Cotton's <sup>8</sup> patient the cause was direct violence. Several weeks of fixation did not improve the condition and she finally was lost sight of. Ozenne <sup>9</sup> reported two cases. The first in a young girl who dislocated her pisiform on attempting to lift a package which she had just put down. The displacement bone could be felt beneath the styloid of the ulna, and there was a depression at the normal site of the pisiform; no X-ray examination was made. The hand was immobilized for two weeks but the bone remained dislocated. Six months later function, except adduction of the hand, was good. The second patient was seen ten years after his injury, which in this instance was also produced by lifting a heavy object.

The cause of dislocation of the pisiform may be either a direct blow or muscular violence. In the instant case it would be impossible to state which was the causative factor. In spite of the relatively exposed position of the bone, the fact that it gives somewhat, coupled with the fact that its capsule is strongly reinforced by extensions from the internal lateral and anterior annular ligaments as well as from the flexor carpi ulnaris, prevents more frequent injuries to it. The disability resulting from the dislocation is slight. If it were greater it would be a simple procedure to suture the pisiform in place.

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TRANSACTIONS  
OF THE  
PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held October 3, 1921*

The President, GEORGE G. ROSS, in the Chair

GAS GANGRENE

DR. FRED L. HARTMANN reported the following case of gas gangrene because of its rarity in civil life:

The man, an adult male, was admitted to the service of Doctor Ross in the Lankenau Hospital, September 5, 1920, on account of an obscure abdominal condition. Upon opening the abdomen, an abscess posterior to the cæcum was revealed. The postoperative course was much disturbed by persistent hiccough. On the seventh day the urinary output had dropped to 700 c.c. For the purpose of stimulating the kidney action, a hypodermoclysis in the thighs of 1000 c.c. normal saline solution was performed. The usual aseptic precautions were observed.

Thirteen hours later the man began to complain of vague pains in the right leg and thigh. These gradually grew worse until after twenty-three hours, a small area about two inches in diameter of emphysematous crepitation was felt at the site of the hypodermoclysis needle puncture of the right thigh. Two hours later the pain had become much more severe, and the examination revealed that the region had become emphysematous from a little above Poupart's ligament down to the ankle. The limb was pale in color and cold with purplish mottling on the dependent portions. The thigh was drum-like but not tender to pressure. No emphysema of the muscles of the lower leg, the gas being under the skin. Temperature, 101.3°; pulse, 110; respiration, 32.

Multiple small incisions were made in the thigh. Gas of a pungent odor escaped. There was no bleeding. Incisions were continued until the entire thigh had been laid open by multiple incisions extending down to the bone. Skin incisions were made in the lower leg. No bleeding was encountered. The blood-vessels were collapsed. The muscles were pale and spongy. The wounds were flushed with hydrogen peroxide and wet dressings of potassium permanganate were applied. The patient was relieved by this treatment but rapidly grew weaker and died two hours after the thigh was laid open. His mind remained clear until the end. At no time did he have convulsions.

After death the right leg on both skin and muscle surfaces was deep purple in color, giving out a pungent foul odor of rotting fish. Examination of cultures two hours after they had been made revealed glucose agar broken up by gas bubbles. No gross growth visible.

## HIGH LIGATION OF THE CYSTIC DUCT IN CHOLECYSTECTOMY

The speaker said that it is of importance for surgeons to know that the bacillus of Welch in its most virulent form is not confined to the peculiar soil of Flanders and France, but is present in the vicinity of Philadelphia. He was cognizant of three cases of traumatic gas gangrene in Philadelphia within the past two years.

The source of infection in this patient may be a matter of discussion. The first and most logical one is that the organism was carried to the muscles by the hypodermoclysis needle. On the other hand in this patient there was present an old omental abscess communicating with a perforated appendix. It is a well-known fact that human fæces harbor the bacillus of Welch. Is it not possible that during the post-operative period, especially when the gauze drain was removed, opening up avenues of absorption, the organism already present in the abscess cavity may have gained access to the blood and have been carried by the blood stream to the muscle at the site of the saline injection, where there existed a focus of devitalized tissue?

## HIGH LIGATION OF THE CYSTIC DUCT IN CHOLECYSTECTOMY

DOCTORS HARTMAN, SMYTH and WOOD presented a paper with the above title recording the observations made in the Laboratory of Surgical Research of the University of Pennsylvania. For this paper see page 203.

DR. MURAT WILLIS, of Richmond, Va., called attention to the experimental work of Doctors Judd and Mann, where they found dilatation of the extra-hepatic ducts following removal of the gall-bladder. They concluded that this dilatation was purely mechanical, but among their experiments they reported one in which the muscle of Oddi was cut but still there was dilatation of the extra-hepatic ducts. He agreed with the essayist that in all likelihood this dilatation is a physiological or compensatory dilatation. From clinical observation he felt satisfied that any pressure sufficiently great to produce dilatation of the extra-hepatic ducts would be sufficient to produce jaundice. Nobody reports jaundice following cholecystectomy.

DR. J. E. SWEET, Philadelphia, said that his work upon the function of the gall-bladder has led to the conclusion that its function is perhaps more simple than had been thought.

The lymphatics of the gall-bladder are very highly developed. If a suitable solution is placed within the gall-bladder, and the lymph coming from the gall-bladder is collected, the presence of the injected fluid can be demonstrated in the lymph in a very few seconds. Therefore they are coming to the conclusion that the function of the gall-bladder is simply to store the bile which is secreted between the periods of active digestion, or, possibly, not so much to store it, since this implies future use, as to deviate it from the intestine during these periods; and since the capacity of the organ is so small, relative to the total amount of bile secreted during this time, the effectiveness of the process is increased by a process of concentration, or inspissation, accomplished by handing back to the system the fluid part of the bile through the lymphatics.

As to the question of the mechanism by which the gall-bladder empties itself, they had been unable to reach a definite conclusion. Surgeons talk about the contractions of the gall-bladder. But these movements refer to the demonstration of the waves of contraction which are due to the contraction of the smooth muscle, waves common to all smooth muscle, and which are too trivial to play any part in the emptying of the organ. They are inclined to the belief that the only mechanism which can empty the gall-bladder is the general intra-abdominal pressure, supplemented, possibly, by the filling of the stomach.

DR. NICHOLAS M. ALTER, of Pittsburgh, agreed with Doctor Sweet as to the importance of the gall-bladder, when it has normal function. The question arises, however, how the gall-bladder will perform its function under pathological conditions, when mostly bile-stained mucus is contained in it and its wall is inflamed. The biliary ducts may also undergo considerable changes. Whatever the function of the normal gall-bladder may be, it cannot be a contra-indication for the surgical treatment of a diseased gall-bladder.

#### CARCINOMATOUS PAPILLOMA OF THE RENAL PELVIS

DOCTORS LANDON and ALTER read a paper with the above title.

DR. B. A. THOMAS remarked as to terminology which seems to be somewhat confusing, so far as papilloma and carcinoma of the urinary tract is concerned.

Carcinoma of the kidney begins either in the parenchyma or in the pelvis. As he interpreted this presentation the case is one of a carcinomatous degeneration of papillomata of the kidney. Obviously when a papilloma undergoes carcinomatous change, it ceases to be any longer a papilloma. It is then a carcinoma—a papillary carcinoma, if you please. It seems to be going a little bit astray in the pathology of tumors of the kidney to speak of a carcinomatous papilloma. The classification of these tumors, when of the bladder, is a matter of considerable moment, for upon their correct identification treatment depends; if papilloma, fulguration, cystoscopically, invariably; if carcinoma cystoscopic fulguration never. In the urological mind this question has been threshed out and today urologists are in perfect accord and understanding on the matter. With others the question still seems difficult and chaotic. This kidney tumor is certainly an unusual one. Even a papilloma of the kidney is a very rare condition. He believed there was only one case found in some ninety-four cases of kidney tumor covering a period of ten years at the Massachusetts General Hospital, and Charles H. Mayo found one case in over seven hundred cases of kidney tumor. When it comes to a malignant or carcinomatous degeneration of a papilloma, certainly Doctors Landon and Alter have presented a very rare specimen.

There is no question but that the diagnosis in these cases is difficult. Hemorrhage is not as important a factor as has been commonly believed. It certainly does not occur in more than fifty per cent. of the cases as a primary



FIG. 1.—Experimental fracture of lower end of tibia extending into ankle joint.





## CRANIAL DEFECT

symptom; tumor in not more than thirty per cent., and pain in less than ten per cent. Too great reliance cannot be placed upon this clinical sign as a guide to diagnosis.

### DOUBLE FRACTURE OF THE TIBIA INVOLVING THE ANKLE-JOINT

DR. A. P. C. ASHHURST referred to a skiagraph which had been shown by Doctor McKnight at the May meeting, which had been reported as a "double fracture of the tibia," but of which only the antero-posterior view had been presented. Doctor Ashhurst at that time had ventured to disagree with the diagnosis, and had suggested that very similar appearances would be presented by a skiagraph (antero-posterior view) of a fracture splitting off a large wedge from the postero-lateral surface of the lower articular surface of the tibia. Such a fracture had been produced experimentally by Doctor Ashhurst, and the skiagraphs of the lesion (Fig. 1) made by Doctor Holloway were now presented to the Academy; the antero-posterior view, he thought, was much the same as in Doctor McKnight's case, while the lateral view showed clearly the single fragment which was detached.

## CRANIAL DEFECT

DR. J. S. RODMAN reported the following cases:

CASE I.—A. G., woman, age twenty, on April 6, 1917, was kicked in forehead by horse. Sustained a compound comminuted fracture of frontal bone and right eye was destroyed. Comminuted fragments removed at once at hospital. Right eye enucleated April 9th. Remained in the hospital four weeks and in bed at home four weeks. A bulging about size of a fist developed on side of injury immediately after fracture. This mass pulsates. Patient states that it is smaller when she is lying down. She was admitted to Dr. J. B. Roberts' service in the Polyclinic Hospital, March 2, 1919, with pulsating meningocele in right supra-orbital region about size of lemon—right eye missing. Sac of meningocele tapped on three occasions and a clear fluid removed.

Operation, March 20, 1919, was: Operated 8.30 A.M.; 25 c.c. clear fluid removed from sac. Transverse incision. Opening found in skull—long diameter horizontal about one inch below surface, about three inches in length and one inch wide. Piece of fat and occipito-frontalis fascia made into free graft and stitched into opening with fascial side to brain. Fine silk used as suture material. Graft removed from supra-orbital region. Remains of sac stitched close over graft; redundant scar and skin removed. Only normal skin saved.

Patient seemed markedly improved following operation and remained so for about six months. Pulsation returned in meningocele, however, and general condition gradually grew worse. Status epilepticus suddenly developed March 19, 1921. Epileptiform convulsions began about 3 A.M. of one morning and ended at noon of same day. No convulsions since then.

April 4, 1921, was operated upon for relief of the cranial defect. Traumatic supra-orbital and frontal—right side. About size of hen's egg. Closure—first stage plastic—skin. Removing an elliptical por-

tion of skin about three inches long—one and a half inches in width. Skin edges mobilized and brought together over defect. (Black silk.)

CASE II.—Woman, age twenty-three years, was admitted to the Presbyterian Hospital, February 9, 1921. She complained of convulsions starting in left leg or left hand and with a slight drawing up of the left corner of the mouth. These convulsions become progressively worse, lasting thirty seconds to one minute, and ending quite abruptly.

These attacks started about four years ago. At that time there was only a slight twitching of the left side of the face. For the past four or five days she has had Jacksonian type of convulsion as described above. She seems to know when the convulsion is coming because she indicates this to the nurse; also seems to be conscious during the attack. Pupils equal but contracted and seem to be fixed (due to morphia?), not contracting to light or accommodation. Ocular movements normal in all directions.

Voluntary movements of facial muscles on right side are normal; on left side the angle of the mouth cannot be drawn up as well as the right, but it is not completely paralyzed. Masseter muscles contract normally. Muscular power of upper and lower limbs is equal and normal. Biceps and triceps reflexes also knee jerks are equal and distinctly exaggerated. There is no ankle clonus and plantar reflex is normal on each side. Sensation for pin point seems to be normal everywhere.

During examination patient had two attacks in which facial muscles of left side *only* were involved. There was at first tonic contraction and then clonic convulsion, chiefly of lower facial muscles, but the orbicularis and frontalis were also involved. The tongue was drawn to left lower jaw; was moved clonically. Platysma and sternocleidomastoid stood out prominently on left side, but none of muscles of shoulder or upper limb were affected. Patient states, however, that attack is ushered in with a sensation over left thigh.

During these attacks just described it is positive that upper and lower limbs were *not* involved. After the attack ceased, there was no twitching of facial muscles. No loss of consciousness during the attack.

Provisional neurological opinion probably a lesion in Rolandic region or right side in lower portion, involving chiefly the face area.

Report of eye examination (Doctor Radcliffe): Right and left pupils dilate regularly. Media clear. Disc outlines distinct. No pathological changes in eye grounds with exception that there is a slight fullness of the optic disc. Wassermann negative. States that facial contractions do not come as often as yesterday. Attacks come less frequently, but seem to last longer. States that since yesterday "aura" began in left hand. Before this aura seemed to begin in left foot. More or less constant, moderately severe headache and vertigo. Examination shows distinct weakness of left face, chiefly of lower muscles—upper portion seems almost normal. The left upper limb does not seem distinctly weaker than the right, but movements and grip of left hand are suggestive of beginning impairment of function—but it is very indefinite. Patient yawns frequently. Sensation of fifth nerve distribution is normal. Complains of pain in teeth of left side.

## CRANIAL DEFECT

DOCTOR CADWALADER, in consultation, recommended operation on right side of skull for lesion probably situated in face area of motor cortex. It is not certain that lesion is a tumor.

February 17th: Operation by Doctor Rodman. Ether anæsthesia. Patient in sitting posture. Incision semicircular in temperoparietal region. Osteoplastic flap laid back. Dura exposed; apparently normal except for perhaps a slight bulging over motor area. Dura incised and flap laid back. The brain substance protruded through the incision a little further than normal. No tumor or other lesion demonstrable. Palpation revealed no evidence of any definite mass under the bulging area. An exploratory puncture was made at this site but no fluid obtained. The dura, pericranium and skin were sutured in three separate layers. Patient required a stimulation for about twelve hours after operation. After a stormy period of twenty-four hours convalescence uneventful. Symptom free since.

TRANSACTIONS  
OF THE  
NEW YORK SURGICAL SOCIETY

*Stated Meeting Held October 26, 1921*

DR. JOHN A. HARTWELL, President, in the Chair

CYST OF THE POPLITEAL SPACE

DR. JAMES N. WORCESTER presented a man twenty-eight years of age, who in May, 1919, first noticed a small swelling in the right popliteal space which was not accompanied by pain and not preceded by any trauma. This swelling gradually increased in size until in January, 1920, it had reached the size of a hen's egg and markedly interfered with walking; in damp weather there was slight pain and swelling.

In May, 1920, patient was operated on in the Marine Hospital, Staten Island. The details of the operation are unattainable, but the operating surgeon told him that it was a non-malignant cyst and incidentally added that it was a very queer condition.

A recurrence of the swelling was noticed within a month of the time of operation and increase in size was gradual. The only other point of interest in the history is that he has been operated on for fistula in ano and is supposed to have had an inactive pulmonary tuberculosis.

May 1, 1921, he entered the surgical service of the Public Health Service Hospital at Polyclinic Hospital. He then presented in the right popliteal space an elastic mass about the size of a lemon, over which lay a four-inch scar. The mass is not tender; extension in knee is normal; flexion is limited to one-half; there is no fluid in knee-joint.

X-ray of the joint was negative. Pressure over mass does not cause any diminution in size.

Operation was done on May 17, 1921. In the popliteal space just beneath the skin was found a thin-walled sac about the size of a lemon; this extended down to the posterior surface of the capsule of the knee-joint, but was not in any way connected with it or with any of the bursæ. In dissecting this free from the scar tissue of the previous operation the sac was opened and a semi-gelatinous clear fluid escaped. The main sac was easily freed, but running from its upper angle was found a strand of dense tissue about three-fourths of an inch in diameter. On cutting into this it was found to have a definite lumen connected with the main cyst. This strand ran in the substance of the semi-membranosus muscle and was dissected from this and followed up to where it disappeared beneath the glutei muscles and running to the neighborhood of the hip-joint where its connection with the hip-joint was impossible to determine. Proceeding from the lower portion of the main cyst was a second similar prolongation which ran into the deep muscles of the calf between the two origins of the gastrocnemius muscle.

## PARTIAL GASTRECTOMY FOR PENETRATING ULCERS

By a ten-inch incision over the popliteal space the cyst was freed by dissection, as was also its continuation upwards; this continuation was cut off at the highest possible point. A similar procedure with the lower prolongation and the muscles brought together with plain gut and skin with silkworm and silk. The wound healed by primary union. To date there has been no recurrence. The pathologist's report was simple cyst lined by fibrous connective tissue. The contents of the cyst looked like the gelatinous contents of a bursa.

## PARTIAL GASTRECTOMY FOR PENETRATING ULCERS

DR. RICHARD LEWISOHN presented four patients upon whom he had performed a partial gastrectomy for penetrating ulcers of the lesser curvature and the posterior wall of the stomach. The patients were all males, twenty-three, twenty-eight, thirty-eight, and fifty-five years old, respectively. Three patients had been suffering from gastric distress for one year or less, whereas one patient gave a ten-year history. He had had an appendectomy performed upon him at another hospital eight years previously. This operation, however, had failed to give any relief of his symptoms. The complaints of these four patients were almost identical: typical hunger pains about one hour after meals, with marked intermission of their symptoms.

The X-ray examination showed in three patients the typical picture of a penetrating ulcer of the lesser curvature; whereas the last patient, operated upon three weeks ago, had no defect. He had, however, a slight residue in his stomach after six hours. This residue in association with a very typical ulcer history was sufficient indication for operative interference.

The operation consisted in partial gastrectomy. After ligation of the vessels, the stomach was divided proximally to the ulcer on one side and just distally from the pylorus on the other side. In one case the ulcer occupied a large portion of the posterior wall, and was so densely adherent to the pancreas that the base of the ulcer was left attached to the pancreas. This case, technically the most difficult of the lower operations, had very large glands along the lesser curvature and in the transverse mesocolon, which aroused a suspicion of the malignant nature of the ulcer. If it were a carcinoma of the stomach, this case would have been inoperable on account of extensive glandular involvement. However, it was decided to give the patient the benefit of the doubt. Microscopical examination of this, as well as of the other three ulcers, showed benign ulcer. The glands in the case just mentioned showed inflammation, but no malignancy. This patient is feeling very well now, one and a half years after the operation.

The gastro-intestinal continuity can be reestablished by either the Polya-Balfour method or by gastro-enterostomy. Button gastro-enterostomy was used in these four cases. Before closing the gastric end, one-half of the button is dropped into the remnant of the stomach. After stomach and duodenum have been closed in layers, and after the other part of the button has been inserted into the jejunum, a very small stab is made into the posterior wall of the stomach. The gastric half of the button is then pushed



through this opening and stomach and jejunum are thus united. This method makes anastomosis a very easy procedure, even in extensive resections. The abdomen was closed without drainage.

All the patients made uneventful recoveries. Three patients left the hospital two weeks after the operation; one stayed seventeen days. The buttons passed without causing any trouble in three patients. The fourth patient (operation three weeks ago) has not passed the button as yet.

Doctor Lewisohn stated that simple gastro-enterostomy fails to cure penetrating ulcer at or near the lesser curvature. He had seen two cases, where gastro-enterostomy had been performed previously by other surgeons. Reoperation and excision of the ulcers cured these cases. Simple excision and sleeve resection are apt to cause hour-glass formation. Local excision with knife or cautery, followed by gastro-enterostomy, gave better results. He had performed this operation on six patients. However, the final results are far better following partial gastrectomy. For this reason the more radical procedure was applied in these four cases. These patients are perfectly well, without any discomfort, though in two of them more than two-thirds of the stomach was removed at operation.

DR. JOHN A. HARTWELL corroborated Doctor Lewisohn's statement that these cases did better than those in which mere excision of the ulcer was done, his experience corresponding to the results obtained at Bellevue where most of the operations had been done by Doctor Woolsey. In general it was found that the cases with this kind of operation were more comfortable and freer from symptoms. But even with this operation these patients should take great care all their lives after operation to avoid a recurrence of symptoms by discretion in diet.

DOCTOR LEWISOHN added that these patients had to keep to a strict diet for a year at least. It was not sufficient merely to excise the ulcer and perform a gastro-enterostomy. On leaving the hospital they were given a printed slip listing what foods to eat, and it had been found that if they kept within these limits for a year or longer the ultimate recovery was complete. But if they fall into bad habits and eat anything they like, the results are not good. The cases shown were all completely free of symptoms.

#### EXTIRPATION OF ONE (LEFT) ADRENAL GLAND FOR THE CURE OF EPILEPSY

DR. HERMANN FISCHER, in presenting a patient, said that up to the present time the efforts of surgeons to cure epileptic convulsions have been mainly confined to operations on the brain and on the skull, with the very few exceptions in which peripheral irritation of old scars or some nasal or other peripheral pathologic condition was held responsible for the production of convulsions. Recently Heinrich Fischer, of Giessen, has advanced a very interesting and new theory which he has substantiated by animal experiments.

He found that by reduction of adrenal substance in the animal body, the tendency to convulsions can be reduced. His experimental work on rabbits



## EXTIRPATION OF ADRENAL GLAND FOR CURE OF EPILEPSY

showed that in these animals no more convulsions by amyl nitrite could be produced after the adrenals had been removed. In the opinion of Fischer the animal nervous system played a subordinate rôle in the production of convulsions. It is the vegetative nervous system and the organs of internal secretion to which our attention must be directed in the endeavor to solve this vexed question. By reducing the substance of adrenal tissue muscular tonus is reduced and, in consequence of this, other stimuli causing muscular irritability become less effective. This theory of Fischer has been taken up by Brüning and put to a practical test in fourteen cases of severe epileptic convulsions, by removing a part or a whole of one adrenal gland.

He reports no mortality. Three cases are still under treatment. Of the eleven cases, five are cured, respectively, very much improved. In five cases no material improvement. In one case attacks are less in intensity and duration but occur more frequently. No result in three cases (age—thirty-eight, fifty-two, forty-five) who had their attacks for a long time. Characteristic for all cases is, that the attacks cease immediately after the operation. If new attacks occur they can usually be suppressed by administration of very small doses of sedobrol or luminal 0.05 t.i.d., whereas all these medicaments had no influence at all before the operation.

In January, 1921, the following case of epilepsy of long standing came under the observation of the reporter, referred by Dr. N. Ransohoff.

The patient was a man twenty-five years old, who had been suffering from epileptic attacks for sixteen years. His family history is negative as far as nervous diseases are concerned, with the exception of an uncle of his mother who died from "softening of the brain." The beginning of his disease dates back to early childhood when he was subject to frequent attacks of convulsions. When seven years old he was hit by a trolley-car and pushed several feet; he did not sustain any injuries, but was very much terrified by the accident. After this psychic trauma he began to have epileptic attacks more frequently and more severe. Slowly the disease has progressed in spite of long treatment, medical as well as surgical. He now has ten to fifteen attacks every night, his psychical condition is deplorable. He had scarlet fever, whooping cough, measles and mumps. At seven years of age he had chorea which lasted one year.

Up to 1914 his attacks were of the type of epileptiform equivalents and petit mal, after that he had typical attacks of grand mal. In 1910 circumcision and in 1915 a subtemporal decompression on both sides was done without giving any relief. In 1918, following a series of attacks, patient hallucinated for several days. Attacks are more frequent at night. Complains of frontal headaches and occasional attacks of temporary blindness after attacks.

He was a well-built young man of twenty-five years of age, slow in coördination of speech and movements, rather expressionless face. Upon questions he reacts very slowly, has difficulty in speaking as he forgets words and is unable to finish a sentence. He is listless towards

his surroundings and is aroused with difficulty. His mental condition is one bordering on idiocy. His head was well developed and presented scars of two operations for subtemporal decompression. The pupils react equally to light and accommodation, vessels normal, optic muscles normal, optic disk normal, a little pale on temporal side.

The report as to endocrine condition, made by Dr. A. S. Blumgarten, was as follows: The patient is a rather dull, lethargic blonde young man, slow and deliberate in his movements and in speech. The skin is markedly pigmented, especially around the lower abdomen, acne on back. There is a moderate growth of hair over lower abdomen, legs, thighs and buttocks. There is no Sergeant's line. There is a marked generalized adiposity. The head shows evidence of previous trephining operations. The forehead is prominent and broad. The lobes of the ears are attached to the side. The nose is normal and not unusually broad. The lips are thick and prominent. The teeth are in excellent condition; there is no increased interdental spacing, but the lower set come directly in apposition with the upper. The neck is short and stocky, the thyroid is not enlarged. Chest is broad, the costal angle is wide, the breasts are well developed. The extremities are normal, the hands are rather delicate, the fingers are long and pointed. No tremor, no cyanosis.

Sugar tolerance slightly diminished; blood chemistry slightly low sugar; pilocarpine test negative; Goetsch test moderately positive; blood pressure, systolic, 85; diastolic, 55.

Conclusion: The patient is a pituitro-adrenal type.

As all attempts of a cure had been futile in this case and as the condition of the patient was becoming worse and more deplorable every day, it was deemed justified to give this new operation a trial.

*Operation.*—*Extirpation of left adrenal gland*, February 12, 1921. Typical lumbar incision (Bergmann-Israel) as in operation for nephrectomy with resection of twelfth rib. After exposure of the fat capsule of the kidney, the kidney, together with its perirenal fat capsule, was dislocated downward by introducing one hand into the wound and by tearing the loose areolar tissue between the diaphragm and the upper pole of the kidney capsule. By this manoeuvre the kidney could easily be pushed down far enough to expose the upper pole of the fat capsule. The perirenal fat capsule was now carefully separated with blunt forceps until the flat, greenish-gray adrenal gland was seen resting on the top of the kidney. The organ was now carefully removed from the upper pole of the kidney by blunt dissection, a small arterial branch coming down from the diaphragm was torn, the main artery and two small veins coming from the renal artery and vein, respectively, had to be tied. One has to exercise some care in dissecting the median aspect of the gland, as it lies in close contact with the renal vein.

The organ was removed in toto without tearing. There was no bleeding of any account. A cigarette drain was put in the bed of the

## TUBERCULOUS ABSCESS OF THE CHEST WALL

removed organ and led out through the wound; wound closed down to drain.

The operation lasted one hour and five minutes.

The pulse after operation went up to 140, but soon came down to 90-100.

The blood-pressure which was 85/55 before operation jumped up to 110/65.

On the third day post-operative blood-pressure was 115/65. Patient in good condition, mentally much brighter. Wound was draining rather profusely. His convalescence was smooth.

Two weeks after operation he felt very well, was much brighter and in the last days more alert, took an interest in his surroundings, read the paper and even wrote a postal card to his relatives which he had not done for years. Has had no convulsion since operation.

(On admission to the hospital he had a very severe convulsion, on January 31st and February 2nd; another on February 5th, then one slight convulsion on February 11th. During the night of February 12th, just before operation, three severe convulsions.)

On the nineteenth day after the operation he had five convulsions during the night, each convulsion lasting one-half to one minute. During the succeeding three weeks there were daily convulsions varying in number from one to seven. After March 26th there was a period of two weeks during which there were no convulsions, so that on April 10th, he was discharged from the hospital. Ten days later there were several slight convulsions described as very light as compared to those previous to the operation. Then followed a period of three weeks of freedom from convulsions, after which for a period of five months there were at varying intervals light convulsions. After September 8th there were no convulsions up to October 28th, at which time the history was concluded.

The reporter called attention to the fact that in his opinion, although the patient had not been cured, there has been obtained a distinct improvement. Before the operation he had from ten to fifteen attacks every night—the convulsions being so severe that he had to be held down to prevent him from falling out of bed. The attacks are now less in frequency and intensity and as the records show there have been considerable intervals of complete absence of convulsions.

## TUBERCULOUS ABSCESS OF THE CHEST WALL

DR. HUGH AUCHINCLOSS read a paper with the above title.

## CORRESPONDENCE

### THE USE OF FASCIA LATA TO REPAIR DEFECT OF HEEL

EDITOR ANNALS OF SURGERY:

Sir:

The use of fascia lata for the repair of defects is not at all new, but the result of its use in this case I have to report is at least interesting.

A man, F. W., aged thirty-six, a shoemaker by trade, was referred to me in April, 1918, for osteomyelitis of os calcis, which diagnosis had been confirmed by X-ray.

Three years previous to this time while driving a mowing machine patient was thrown out, and blade severed the tendo achillis. This was sutured and healed by first intention except that patient suffered complete anæsthesia of heel. After his illness he was unable to get employment at his trade (shoemaker), but secured a position on a coal team delivering coal. Eight months later a sore developed on his heel from which sero-purulent material was discharged. Temporary success only was achieved by several attempts to clear up this condition, such as curettement and packing of the os calcis.

In 1918 a further thorough curetting, followed by injections of bismuth paste, finally gave him a clean wound and eventual healing. The resulting scar, which was firmly adherent to the os calcis, left a marked depression in the heel pad. Six months after he resumed work a large, firm callosity filled the previous depression, and within a few days evidence of sepsis was present and a purulent discharge from the original site showed that the condition was not cured.

The dead skin separated with the callosity, leaving a clean scar, the same condition as he had had seven months before. In other words, it was quite apparent that the os calcis was not getting its much needed protection from the pad and a cure must consist of reconstructing the heel pad.

In October, 1920, patient was admitted to Memorial Hospital and plantar surface of os calcis exposed by turning down heel pad with an incision extending from back of heel to outer side of sole. Scar was firmly adherent to os calcis and in detaching it considerable periosteum was denuded.

An incision was then made in the outer side of thigh and a square of fascia lata removed. This fascia was then sewed to make complete covering for the plantar surface of os calcis. Heel pad was sutured back and foot kept at rest for three weeks.

Wound healed by first intention and weight bearing was allowed in six weeks.

Patient resumed work at the end of twelve weeks and now at the end of a year reports perfect function and no recurrence of his former trouble. The heel pad is large and not adherent. In the meantime his anæsthesia has practically disappeared.

CHARLES E. AYERS, M.D.,  
Worcester, Mass.

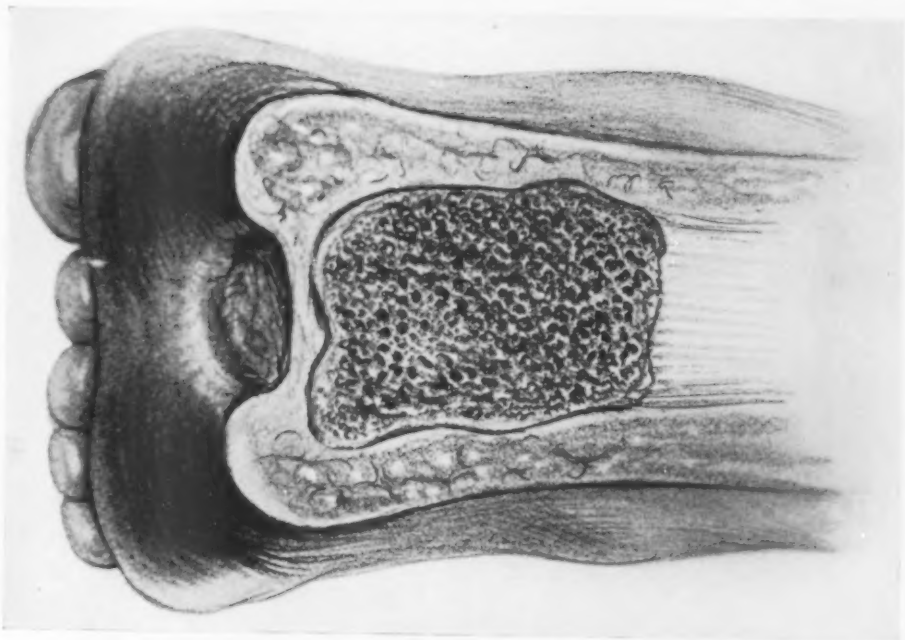


FIG. 1.—Section through os calcis showing scar with loss of heel pad.

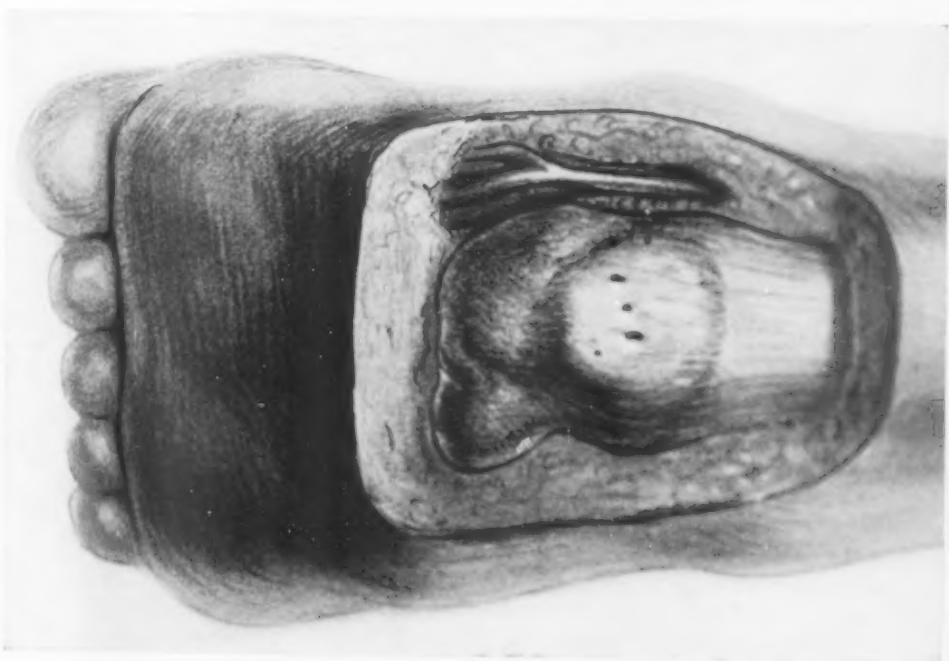


FIG. 2.—Showing normal heel.



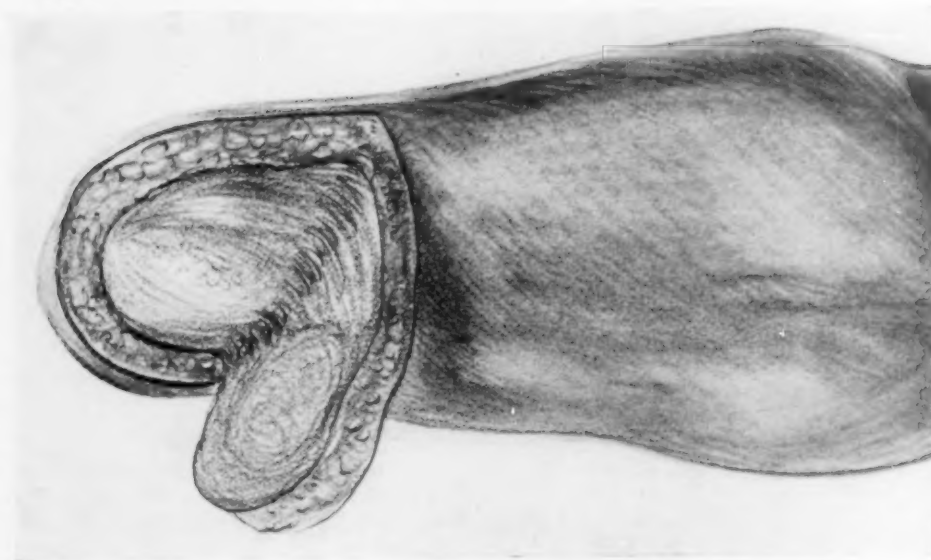


FIG. 3.—Method of exposing the plantar surface of os calcis.

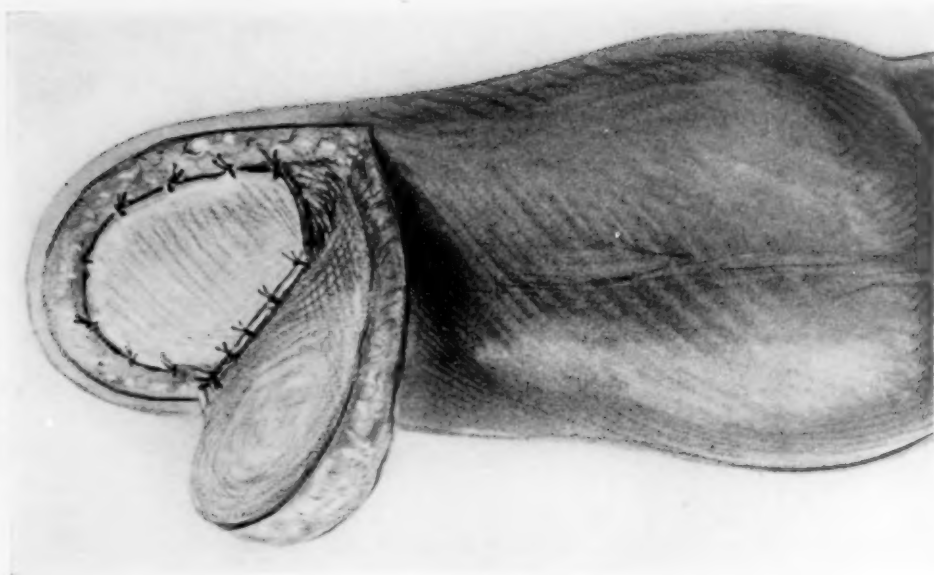


FIG. 4.—Fascia lata sutured in place as protection for os calcis.



## CORRESPONDENCE

### GUNSHOT WOUND OF HORSE-SHOE KIDNEY—GUNSHOT WOUND OF EXTERNAL ILIAC ARTERY

EDITOR ANNALS OF SURGERY:

Sir:

I desire to report through the ANNALS OF SURGERY a case of injury to a "horse-shoe" type of kidney, and also one of severed right external iliac artery, both cases terminating in recovery. The rarity of the conditions involved is the reason of this report.

#### GUNSHOT WOUND OF HORSE-SHOE KIDNEY

The patient, W. M., aged twenty-eight, white, male, American, occupation farmer, was admitted to the Anderson County Hospital, 4.30 A.M., January 21, 1921. About an hour before admission, he had received a gunshot wound. Examination showed the wound of entrance small, round, punctured wound in the lumbar region just to the right of the spine, about the level of the last lumbar vertebra. No wound of exit. He was in a state of shock; blood-pressure 90 over 60. He complained of severe pain in upper right abdomen in region of gall-bladder.

The X-ray showed a bullet in the liver substance anteriorly, about two and a half inches beneath the anterior abdominal wall. Catheterized specimen of urine showed specific gravity 1.020, reaction acid, trace of albumen, no sugar, no casts, many blood-cells. The urine showed blood macroscopically.

The abdomen was opened through right rectus incision. The cavity contained quite a large amount of dark free blood, which was sponged out and intestinal tract explored. No injury to any of the hollow viscera was found. A perforation of the posterior peritoneum over the region of right kidney was exposed. This hole was enlarged and the kidney explored. A large ragged wound which severed the cortex of the kidney at the level of the pelvis was found. The lower pole of the right kidney was fused with lower pole of left kidney by an isthmus of the kidney tissue, about one and one-quarter inches in width, about one inch in thickness. The left kidney was apparently two-thirds the size of the right. Its pelvis felt normal and we were reasonably sure that we felt the ureter coming off from it. The right kidney, or rather the right horn, of the "horse-shoe" kidney was then resected at the thinnest portion of the isthmus, and removed. The blood supply of this kidney consisted of several small arteries that flowed in at the pelvis, instead of a normal artery. The lower pole of the then remaining left kidney was sutured, and the rent in the posterior peritoneum closed. A perforation was found in the under surface of the liver near its posterior border. The channel of the wound ranged upward and forward towards the external surface of the liver. The wound was explored with the index finger for the full length of the finger, but the bullet was not felt nor was the bottom of the wound reached. This liver wound was not bleeding at all freely, and realizing the difficulty we would have in trying to remove a pack in this region, we left it abso-

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lutely alone and closed the abdomen, leaving in a small split rubber tube drain. The right renal region was drained through a stab wound in the posterior lumbar region, by a split rubber tube. Patient was put in a warm bed and given continuous Murphy drip, two per cent. sodium bicarbonate, five per cent. glucose, for two days. He had some reaction on his first day, temperature reached 101°, pulse as high as 130; both came down gradually, and had reached normal by the second day. From thence on his recovery was uneventful. His urinary output first twenty-four hours following operation was 28 ounces. This gradually increased each day until the normal output was reached. He had no jaundice at any time and was discharged on the 17th post-operative day. General condition good, wound healed, primary union. Fluoroscopic examination on the date of discharge showed the bullet just beneath the anterior abdominal wall, over the liver area, at the eighth rib, in the anterior axillary line, probably beneath and in apposition with eighth rib.

In view of this report it is probable that this bullet might have been found at the time of operation by passing hand over upper surface of liver, but patient's condition did not justify any more manipulation than necessary. He was discharged, still carrying the bullet, and was advised against further treatment, unless it began to give trouble. In which event we believe it could be easily removed under local anaesthesia.

### PENETRATING WOUND OF ABDOMEN AND SEVERED RIGHT EXTERNAL ILIAC ARTERY

A negress, age twenty-two, was admitted to the Anderson County Hospital, February 26, 1921. Eight hours before admission she had received a gunshot wound in the lower left abdomen. She immediately went into a condition of shock, with air hunger; the right foot felt cold and numb. She reached the hospital at 2 A.M. the following morning, after fifteen miles drive in a Ford over rough roads, with several hot bricks applied to right lower limb in attempt to keep it warm. When admitted she was in a state of extreme shock. Blood-pressure 80 over 44, extremities cold to elbows and knees. Right lower limb insensitive, some slight movement. Small penetrating wound .22 calibre size, one and one-half inches below and one inch to the left of umbilicus. Abdomen very rigid.

No X-ray work done. Patient carried to the operating room, abdomen opened through longitudinal right rectus incision, abdominal cavity found filled with clotted blood and some fecal matter. After removal of the blood clots from the abdominal cavity the hemorrhage was found coming from a perforation of the posterior peritoneum in the right iliac fossa in the region of the iliac vessels. The parietal peritoneum was then stripped from the lateral abdominal wall, and the external iliac vessels exposed. The external iliac artery was found severed by a ragged wound about half-way between its junction with the internal iliac artery and Poupart's ligament. All the surrounding connective tissue was infiltrated with blood. The artery was plugged up with blood clot and was oozing very little. On attempt at dissection of artery, the clot was forced from lumen of vessel, and it began to spurt.

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The artery was compressed and held while an assistant dissected it up and ligated both ends. No attempt was made at reconstruction of artery as the patient's condition would not justify that kind of procedure. A small tube drain was placed down between the peritoneum and abdominal wall. The alimentary tract was then explored, and fourteen small perforations in the ileum, and six in the mesentery, were found and sutured. The abdominal cavity was irrigated with five gallons of hot saline and the abdomen was closed with a large rubber drain with gauze in the cul de sac. One thousand c.c. saline were given intravenously. The operation was started under very light ether anæsthesia, which was entirely discontinued before we were half through. She was in a state of profound shock when put back in bed. As soon as she reacted, head of bed was elevated. Was given Murphy drip continuously, two per cent. sodium bicarbonate, five per cent. of glucose, morphine freely, nothing by mouth. The right lower limb from knee down remained cold and no pulsation could be felt. Second day following operation developed blebs had formed over the entire right leg from the knee down, due to burns received before admission. She had a rather stormy time for five days, after which the temperature began to drop to near normal, and the abdominal condition began to improve. After two days of apparent improvement the temperature began to rise. She began to get septic from gangrene that was developing in her leg. Great sloughs of burned tissue had been dissected out from her leg and foot previous to this time. The burn on the anterior portion involved the tibia. On the tenth day she was carried back to the operating room and an amputation done. Under ether an amputation at the middle and lower third of the thigh was done.

She suffered very little shock from the amputation, and her general condition began to improve immediately after. Infection in the stump finally cleared up and on April 1st, after thirty-four days' stay in the hospital, she was discharged with healed stump and healed abdominal wound, and in very good condition.

The only reported case of severance of the external iliac artery with survival of the patient that I have been able to find is the one reported at length by Doctor LaRoque, of Richmond, Va., in the March, 1921, number of the *ANNALS OF SURGERY*. In this patient the artery was severed at a lower point and a tourniquet was applied very soon after the accident. He ligated the artery and vein and patient had a complete recovery, and a perfect function of the limb.

The only explanation that I have to offer for the survival of my patient, with a lapse of eight hours from the time of severance to ligation, is that the small bullet caused such a small perforation in the peritoneum which hindered any free outlet of blood, hence the infiltration of the tissues along the artery, the production of enough pressure on the artery to stop the bleeding. Possibly this patient would have developed enough collateral circulation in her limb to have prevented gangrene, had it not been for the extensive burns caused by the heat applied by her family on the way to the hospital.

S. C. DEAN,  
*Anderson, S. C.*

## CORRESPONDENCE

### PARALYSIS FOLLOWING USE OF SEHRT'S TOURNIQUET

EDITOR, ANNALS OF SURGERY:

Sir:

Recently several articles have appeared in the ANNALS OF SURGERY and in other publications advocating the use of the metal tourniquet. In a number of these articles it is claimed that no damage is likely to follow the use of this instrument. I wish to report a case where grave injury was caused to the three main nerve trunks of the arm by its use. A Chinese patient, aged twenty-one years, was attacked by robbers and was severely injured. Among other injuries the tendon of the flexor longus pollicis was divided at the metacarpophalangeal joint. The wounds were of course infected. Patient applied to this clinic for relief six months after his injury. The medium sized Sehrt metal tourniquet was used over a towel around the middle of the arm. This tourniquet was placed above the sterile field. During the operation hæmostasis was not complete and the tourniquet was tightened by an orderly. The dissection was difficult, due to the scar tissue, and the tourniquet was in place nearly one hour. As a result of this the patient showed immediately partial paralysis of the muscles supplied by the radial, ulnar and median nerves, with paresthesia over the distribution of the ulnar and median nerves and complete anæsthesia over the radial distribution. At the present time, five months after operation, sensation and muscular power are normal.

I feel that the serious result following the use of this tourniquet on the arm justifies this report, especially in view of the esthustastic article commending the instrument which appeared in the ANNALS OF SURGERY in 1920.

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